Materials in Design Engineering

SELECTION AND USE OF METALS, NONMETALLICS, FORMS, FINISHES

low pressure reinforced plastics

Manual No. 167

What's New in Materials – p 5
Effect of Section Size on Grey Iron – p 100
Fluidized Bed Coatings – p 91
Complete Contents – p 1

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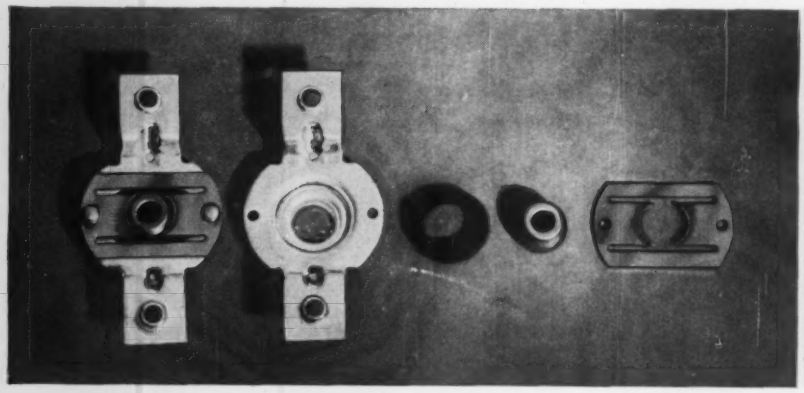
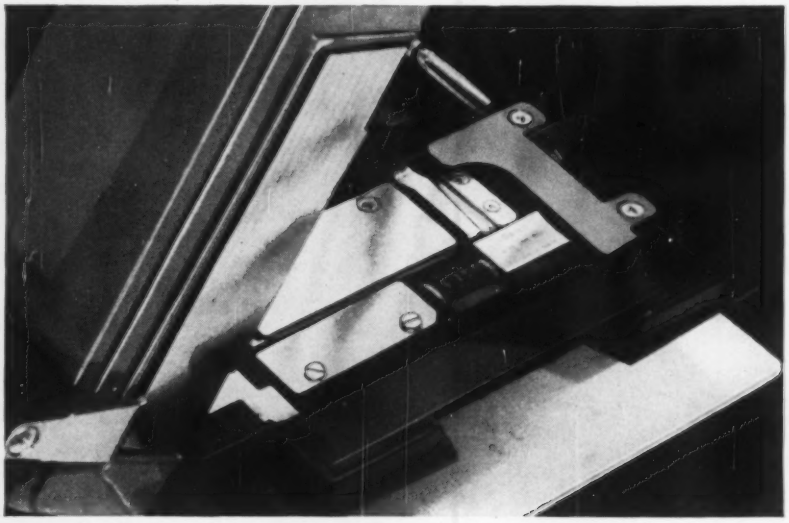
FEBRUARY, 1960

NEW BRONZE
CAN CUT SPRING COSTS—

Superfine-grain phosphor bronze by Anaconda now handling many tough jobs, replacing costlier materials.



RETAINING CLIP for a bronze bearing in the Handy Hannah Hair Dryer was originally of spring steel. Rejections ran 20% in the stamping operation and another 20% at the assembly stage. The Handy Hannah Products Corp., Whitman, Mass., switched to Duraflex, Anaconda superfine-grain phosphor bronze, found it had not only the spring quality and fatigue resistance needed for the job—but also had superior formability which eliminated rejections.



SPRING CLIP takes a steady beating as it holds invoices in place in imprinting machines—used widely in handling charge accounts by retail stores and service stations. In the imprinter (right) made by the Farrington Mfg. Co., Needham Heights, Mass., this clip was originally of beryllium copper. Hearing about the superior fatigue life and endurance limit of Duraflex, Farrington consulted Anaconda technical specialists and decided to try it. Duraflex has been doing the job now for two years, stands up in service, saves $1.50 a pound in material cost.

TESTS by an independent laboratory show that design stresses for Duraflex wire and flat springs can be from 33% to 50% higher than for those made from regular phosphor bronze—yet Duraflex costs no more than regular phosphor bronze. Get the test reports and revaluate all your components requiring spring properties. For copies of these reports or technical help in selecting the right alloy and temper, see your Anaconda representative. Or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5945

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A PRODUCT OF

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Made by The American Brass Company

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FEBRUARY 1960 | VOL. 51, NO. 2

Materials in Design Engineering®

FORMERLY MATERIALS & METHODS

SELECTION & USE OF METALS, NONMETALLICS, FORMS, FINISHES

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What's New in Materials

At a Glance 5

Epoxy Coating Resists High Gamma Radiation 9
Has been successfully applied to steel and concrete surfaces

New Ultra High Strength Steel 9
Offers 7% higher strength than other available low alloy steels

90-10 Tantalum-Tungsten Alloy Forged in Air 11
Alloy is readily fabricated, stronger than tungsten up to 4500 F

Steel Vacuum Degassed in Ladle 12
New foundry method provides sounder ingots for use in forging

What's New in Fluorosilicone Rubbers ..... *R. Naegele, T. Talcott* 13
New compounds and a masterbatch have added to their versatility

Oriented Graphite Made by Commercial Process 16
Anisotropic conductivity useful in rockets, reactors, electronics

Other Contents 16

Engineering & Design

At a Glance 85

Which Soft Solder for Nuclear Service? ..... *A. B. Kaufman* 87
Here are the parameters to consider—and a specific recommendation

Fluidized Bed: Heavy Coatings in One Dip ..... *W. R. Pascoe* 91
An up-to-date look at the materials, their performance, and their uses

Glass-Bonded Mica Offers Stability Plus Moldability ..... *J. E. Faloon* 96
Molded as a plastic, it cures to a hard, stable, dielectric ceramic

Effect of Section Size on Gray Iron Castings ..... *R. C. Bates* 99
Graphs give valuable comparisons of strength, hardness, microstructure

Other Contents 152

MANUAL NO. 167

Low Pressure Reinforced Plastics ..... *M. W. Riley* 103
A 16-page summary of materials, molding methods, design data

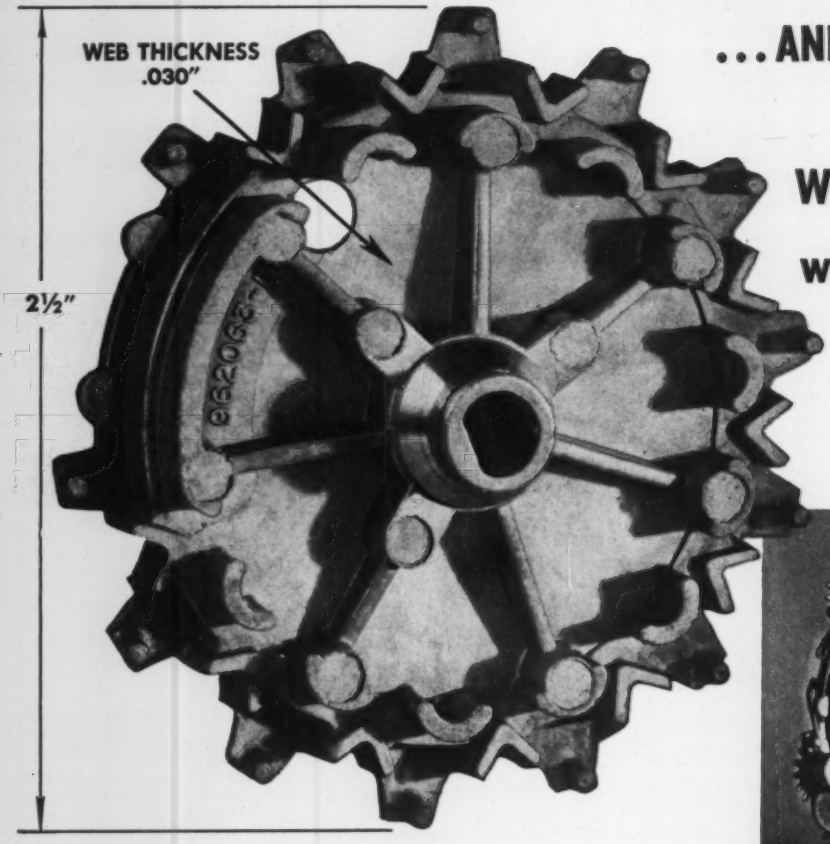
Materials at Work

At a Glance 123

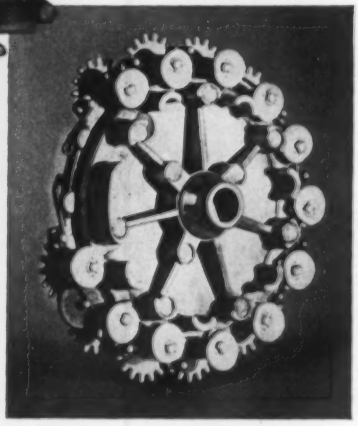
Lead Sheet Forms Lubricating Seal 125
Seals out water, eases wall movement at joints of water power conduits

continued on page 3

IT'S LIGHTER THAN YOU THINK!



...AND UNBELIEVABLY PRECISE WHEN DIE CAST with ZAMAK



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Materials at Work *continued from page 1*

Where to Use Platinum Group Metals ..... *S. S. Rice* 126
These long-life metals can save money in many designs

Reinforced Plastic Wiring Harness 130
Molded harness cuts weight and bulk inside aircraft

Other Contents 131

Prices & Supply

At a Glance 23

Reader Service 37

Technical Literature

Suppliers' New Literature 39

Books 164

Reports 166

File Facts

Corrosion Resistance of Titanium 121

News of Industry

Literature Searching Service to Cover Metallurgy 141

Powder Metallurgists Form New Institute 141

SAMPE Committee Votes Nationalization 142

News of Engineers, Companies, Societies 142

Coming Meetings 150

The Last Word

Engineers Can Be Corrupted, Too 216

Other Departments

Letters to the Editor 18

Indexes: Advertised Products 45

Advertisers 214

NEXT MONTH

Fluorocarbon Fluids
Properties of Pearlitic Malleable Irons
Molded Vinyl Plastisols: What They Can Do
How to Make Low Cost Models of Paraffin
Honeycomb Sandwich Construction, Part I
Which Copper-Base Alloy for a Brazed Part?
Mechanical Properties of Imported Woods
Modern Uses of Graphite
Inexpensive Coatings for Metal Products

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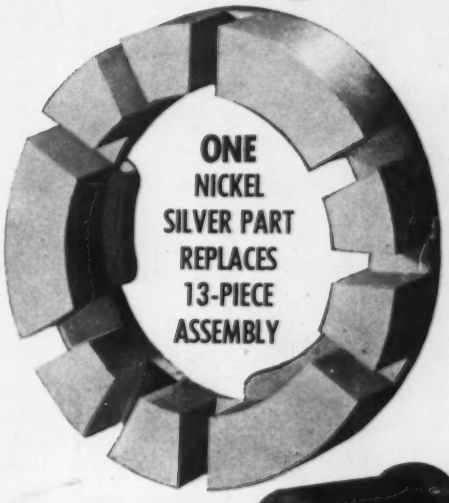

INGENIOUS DESIGN SAVES 95% AND CUTS ASSEMBLY TIME FOR STATOR WINDING AT MINNEAPOLIS-HONEYWELL

Formerly, 13 pieces were machined from brass bar stock and fitted by hand to a plastic ring to provide contact points for this assembly.

TOTAL COST WAS $2.07

CONVERTING TO NICKEL SILVER POWDER, ***ONE PIECE,*** DELIVERED BY THE FABRICATOR* READY FOR ASSEMBLY, IS EMBEDDED IN PLASTIC, THEN CUT BACK TO EXPOSE THE ACCURATELY-PLACED TERMINALS — COST 10¢.

*Sintered Metals, Inc., Boston.

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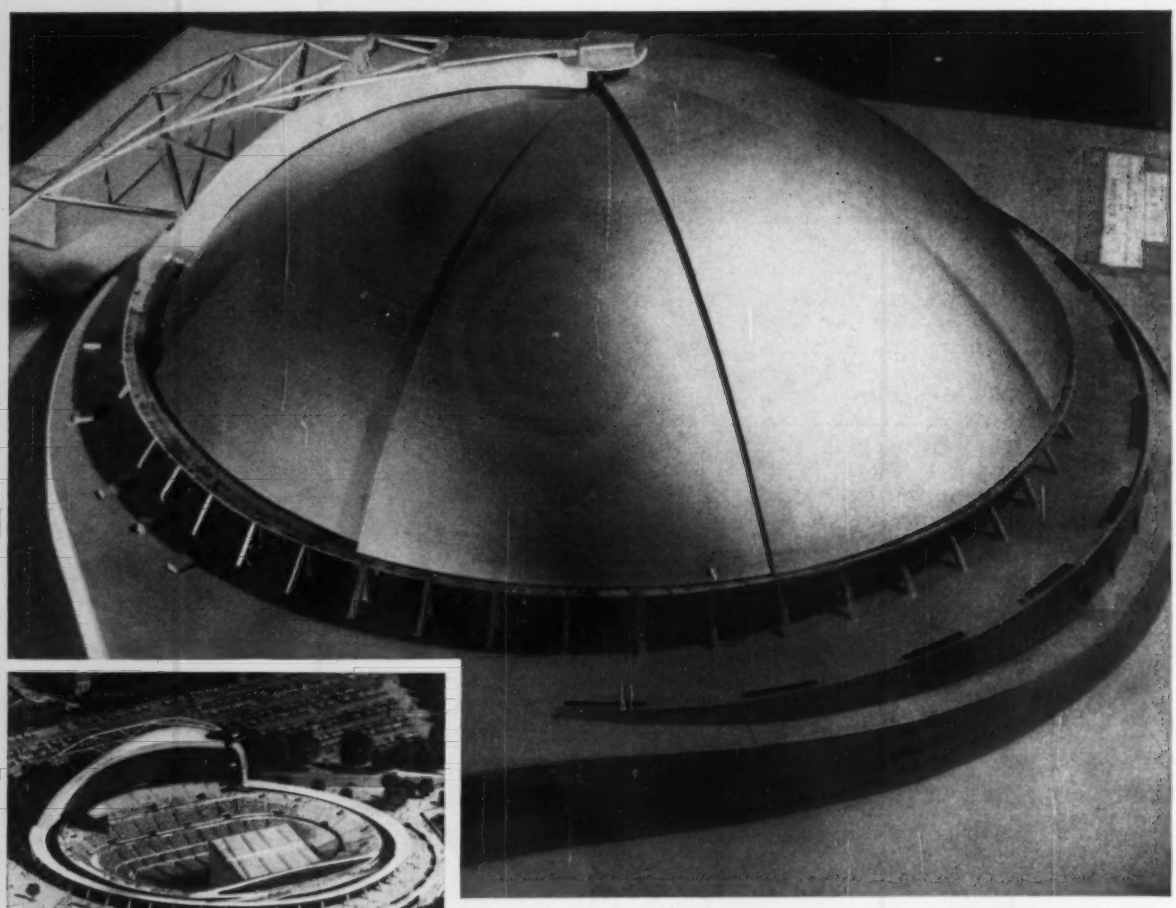

All-weather auditorium in Pittsburgh will be covered by a 415-foot diameter Nickel-containing stainless steel dome. Largest of its kind in the world, the dome will protect an audience of more than 13,000.

"Push-button umbrella roof" of stainless steel gives Pittsburgh a new all-weather auditorium

Watching a play or listening to music under the stars heightens the enjoyment. That is, until a passing shower comes along to wash out the fun. But now comes a new idea in auditoriums. In this one, an umbrella roof of Nickel-containing stainless steel will close at the first drops of rain—and on with the show.

It's a simple concept, but a daring one. Eight huge sections nest together when the dome is open. Push a button, and six of these sections glide quietly together around an outside track.

They looked into all sorts of sheathing materials in designing the dome before choosing stainless – a Nickel-containing stainless steel.

For stainless with Nickel in it is one of the most weatherproof metals there is. It is corrosion-resisting all the way through – in salt air as well as industrial atmospheres. What's more, it's virtually self-cleaning – rainfall alone keeps this metal clean.

No wonder you see Nickel-containing stainless wherever strength, long life and handsome appearance are called for! Not only in buildings – inside and out – but everywhere you look.

Suggest something to you? Can stainless help you solve a problem involving corrosion, stress, appearance, temperature extremes? The way to find out is to write us. We'll see if Nickel-containing stainless steel – or some other nickel alloy – may be just what you're looking for.

THE INTERNATIONAL NICKEL COMPANY, INC.

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INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

What's new IN MATERIALS

...AT A GLANCE

New ceramics for 3200-5000 F service have excellent thermal shock resistance, and can be made readily machinable. By taking a new approach, it is possible to make a variety of refractory ceramics that can be fired at relatively low temperatures (about 1500 F). Prefiring produces stock shapes with good machinability; no shrinkage occurs in the final firing after machining. Bodies are somewhat porous, and have mechanical properties comparable with those of porcelains. (More details in a forthcoming issue.)

Another refractory material is said to withstand continuous exposure to temperatures from 1000 to 3000 F. According to the developer, the new material can be easily fabricated into a wide variety of shapes and sizes. Composition has not been disclosed.

Source: Harco Laboratories, Inc., New Haven, Conn.

A group of clad aluminum sheet and plate alloys for hot water applications is commercially available. The clad materials are said to combine two or more specially designed alloys (compositions not revealed) into a single fabricated form. The cladding is said to act as a "built-in" anode, providing electrochemical protection to the base material.

Source: Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19.

Easy processing and good abrasion resistance are the claims made for a new rubber—a fatty-acid-emulsified, cold-type SBR (styrene-butadiene). The material is recommended for household goods, floor tile, sponge and shoe soles. (More details next month.)

Source: Goodrich-Gulf Chemicals, Inc., 3121 Euclid Ave., Cleveland 15.

A new silicone dielectric fluid now available is said to be ideal for low temperature applications. Reason: it has a pour point below −120 F. The developer says the dielectric is especially suitable for use in airborne equipment subjected to both high and low temperatures. (See Nov '59 issue, p 99, for roundup of synthetic liquid dielectrics.)

Source: General Electric Co., Silicone Products Dept., Waterford, N. Y.

'The strongest aluminum honeycomb core ever produced' is the claim made for a new honeycomb core now in full-scale production. Preliminary test data indicate the aluminum honeycomb core is 15 to 30% stronger than any comparable product now available, the producer says. The honeycomb is made in cell diameters ranging in size from $\frac{1}{8}$ to $\frac{3}{8}$ in., and in foil gages of 0.001 and 0.002 in.

Source: Hexcel Products, Inc., 2332 4th St., Berkeley, Calif.

A 'carbide-stiffened' silicon nitride material is said to withstand cracking after 50 cycles of rapid heating to 1830 F and cooling to room temperature. The developer says the new ceramic can be formed to close dimensional tolerances by conventional machining techniques. The new material is expected to be used as an electrical

insulation on rocket launching platforms; and as catalyst supports, thermocouple sheaths, high temperature furnace structures, and containers for special purification and diffusion operations used in semiconductor manufacture.
Source: Admiralty Materials Laboratory, Whitehall, London, SW 1, England.

Tungsten-coated metal and nonmetallic parts can be obtained rather easily by using a new gas plating technique in which a mixture of gaseous tungsten hexafluoride and hydrogen is passed over a heated part. Tungsten is deposited as pure metal, and impurities pass out with excess gas. The method is similar to one developed by the Bureau of Mines for forming tungsten into tubing and other shapes (see M/DE, Dec '59, p 162).
Source: National Bureau of Standards, Washington, D. C.

A track resistant epoxy electrical insulation can be spray or brush painted over existing electrical insulations. According to the developer, the new material is up to 300 times more resistant to breakdown by tracking than phenolic insulating materials. Other advantages: it requires no baking or special curing, and it has excellent resistance to moisture and chemicals. The insulation is expected on the market shortly.
Source: Westinghouse Electric Corp., 3 Gateway Center, P. O. Box 2278, Pittsburgh 30.

Steel castings with increased impact strength at low temperatures are made possible by a new technique that turns out castings with a sulfur content of 0.003%, compared to a figure of 0.012% in conventional steel castings. Key to the process is the removal of sulfur by means of a reducing slag before, rather than after, other impurities are removed. The lower sulfur content is also said to reduce "hot tearing" during solidification.
Source: General Electric Co., Research Laboratory, Schenectady, N. Y.

A plastics semiconductor material has been developed by Soviet scientists, reports Tass, the USSR government news agency. The material is irradiated polyacrylonitrile. Tass says the plastics semiconductor material is more stable and easier to process than germanium.

Large, nonwelded tantalum sheets measuring 0.02 in. thick by 36 in. wide by 72 in. long are commercially available at a price of $59.16 per lb.
Sources: Kawecki Chemical Co., 220 E. 42nd St., New York 17, and Fansteel Metallurgical Corp., 2200 Sheridan Rd., North Chicago, Ill.

A new heat-treated titanium sheet alloy with a tensile strength over 190,000 psi is now on the market. According to the producer, the alloy is heat treated by a new process that makes it possible to produce sheet free of surface contamination, with better flatness and more uniform properties than previously obtainable. Potential aircraft and missile uses include skins, stiffeners, internal structures, engine parts and heat shields. (More details next month.)
Source: Republic Steel Corp., 1441 Republic Bldg., Cleveland 1.

Pure tungsten that can be cut with a hacksaw has come out of work done at the Bureau of Mines. Still under development, the metal has been hammer-forged at 1650 F (a very low temperature for tungsten) to 70% of its original thickness.
Source: Bureau of Mines, Albany, Ore.

Turn to page 9 for more "What's New in Materials"

Another new development using

B.F.Goodrich Chemical *raw materials*

Coustifab is a lead-filled Geon coated fabric for vibration deadening. It is made by Cordo Chemical Corporation, Norwalk, Conn., and is illustrated here in ceilings and at base of side panels on the aft part of Douglas DC-8 cabins. B.F.Goodrich Chemical Company supplies the Geon polyvinyl material.

LEAD LOADED GEON COATED FABRIC

DAMPENS VIBRATIONS ON NEW DC-8

The roar of jet engine power and speeds of jetliner operation are creating entirely new design problems for engineers charged with dampening vibration and sound. Douglas engineers are solving the problem with a new flexible fabric which dissipates the low frequency vibrations that ordinary acoustical material can't screen out.

The material consists of either cotton or glass fabric coated with a Geon polyvinyl material that has been compounded with powdered lead. This construction provides sufficient barrier mass to dampen and to provide increased transmission loss, yet offers considerably improved flexibility—unlike former materials that actually contained a potentially friable sheet of lead as an inner core or a central layer.

Geon has proved best for this application because it disperses readily in the coating formula, providing excellent coating characteristics and a good bond with the fabric. Versatile Geon provides coatings for many products—from metal to non-woven fabrics. Or you can use Geon to make products like insulated wire, pipe, or foam. A wide variety of resins, compounds, latices and polyblends is available. For the type best suited to improve your product or application, write Dept. GV-1, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

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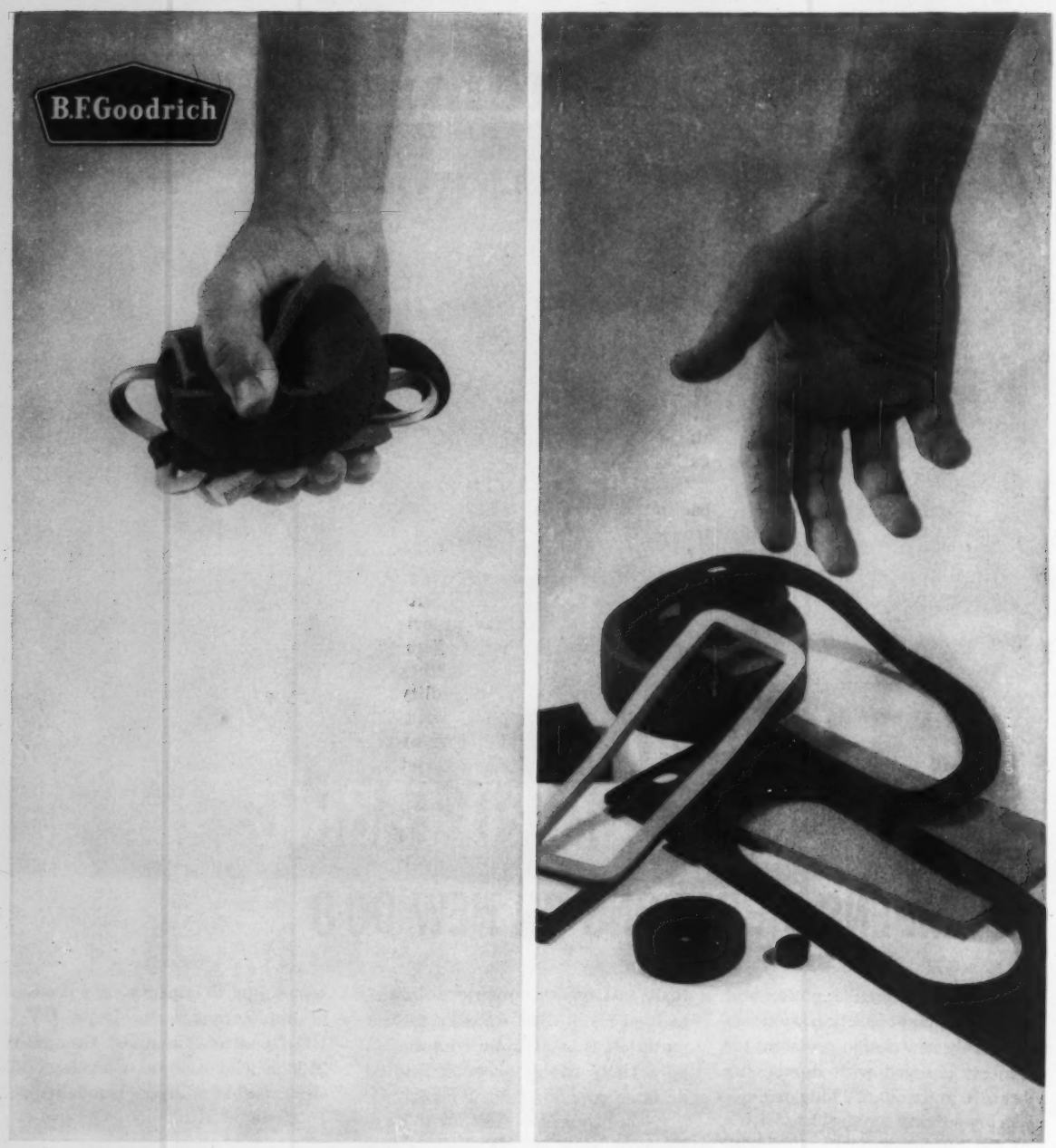


From one source... all this material

B. F. GOODRICH IS A PRIME SOURCE for all shapes and sizes of sponge rubber, closed-cell rubber, cellular polyvinyl chloride and urethane foam. Because of its equipment and production facilities, B. F. Goodrich can efficiently mass-produce this material into sheets, cord, tubing, die-cut shapes and molded forms for cushioning, sealing, shock absorption, vibration damping, insulation and flotation. For full information and help from B.F.Goodrich specialists in cellular engineering, write *The B. F. Goodrich Company, 121 Derby Place, Shelton, Conn.*

B.F.Goodrich *industrial cellular materials*

For more information, turn to Reader Service card, circle No. 390

Epoxy Coating Resists High Gamma Radiation

Can be used on steel or concrete

■ A nuclear radiation-resistant epoxy coating has been developed that will not fail after prolonged exposure to high intensity gamma radiation. The coating has been successfully applied on steel and concrete surfaces at the National Aeronautics and Space Administration's Plum Brook Reactor, Sandusky, Ohio, and was developed jointly by Shell Chemical Corp., 50 W. 50 St., New York 20, and Patterson-Sargent Co., 1325 E. 38 St., Cleveland 14.

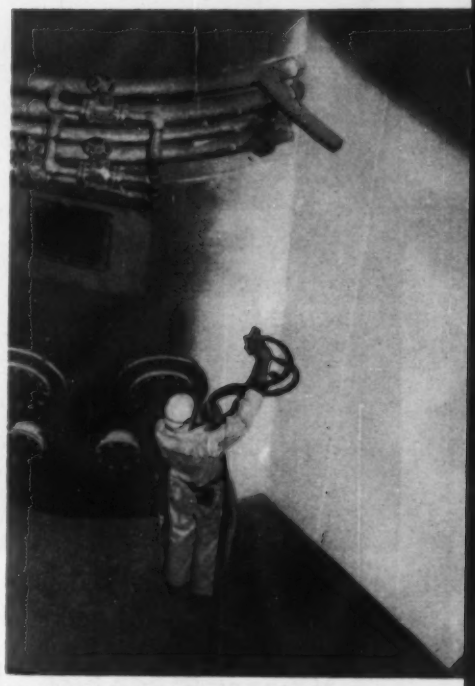
The coating was specially created to prevent the leakage of water (which could be contaminated by an accidental release of radioactivity) through concrete retaining walls. Such leakage could occur if the waterproof coating failed by natural means or from radioactive bombardment.

The unusual amine-cured epoxy coating has been exposed in accelerated tests to a 1,500,000-v electron source. Direct gamma ray exposure would have taken 1000 hr to reach the desired radiation quotient. NASA physicists say that any radiation damage sustained by organic coatings is substantially the same, whether from gamma rays or electrons.

Coated test panels were passed back and forth through the electron beam at 10-sec intervals. After 4½ hr exposure, the epoxy coating had received a dosage of 1×10^9 r. When compared with control panels, there was no evidence of cracking, flaking, bubbling or blistering. As further evidence of the coating's ability to take punishment, it also withstood over 9500 hr of attack by boiling distilled water, JP-4 jet fuel and salt spray.

The radiation resistant coating is a two-part cold curing vehicle requiring a curing agent to complete the chemical reaction which hardens the resin. The same basic epoxy resin is employed for the red primer coat, the gray mastic coat (in which glass cloth is embedded), and the white finish coating.

For more information, circle No. 600



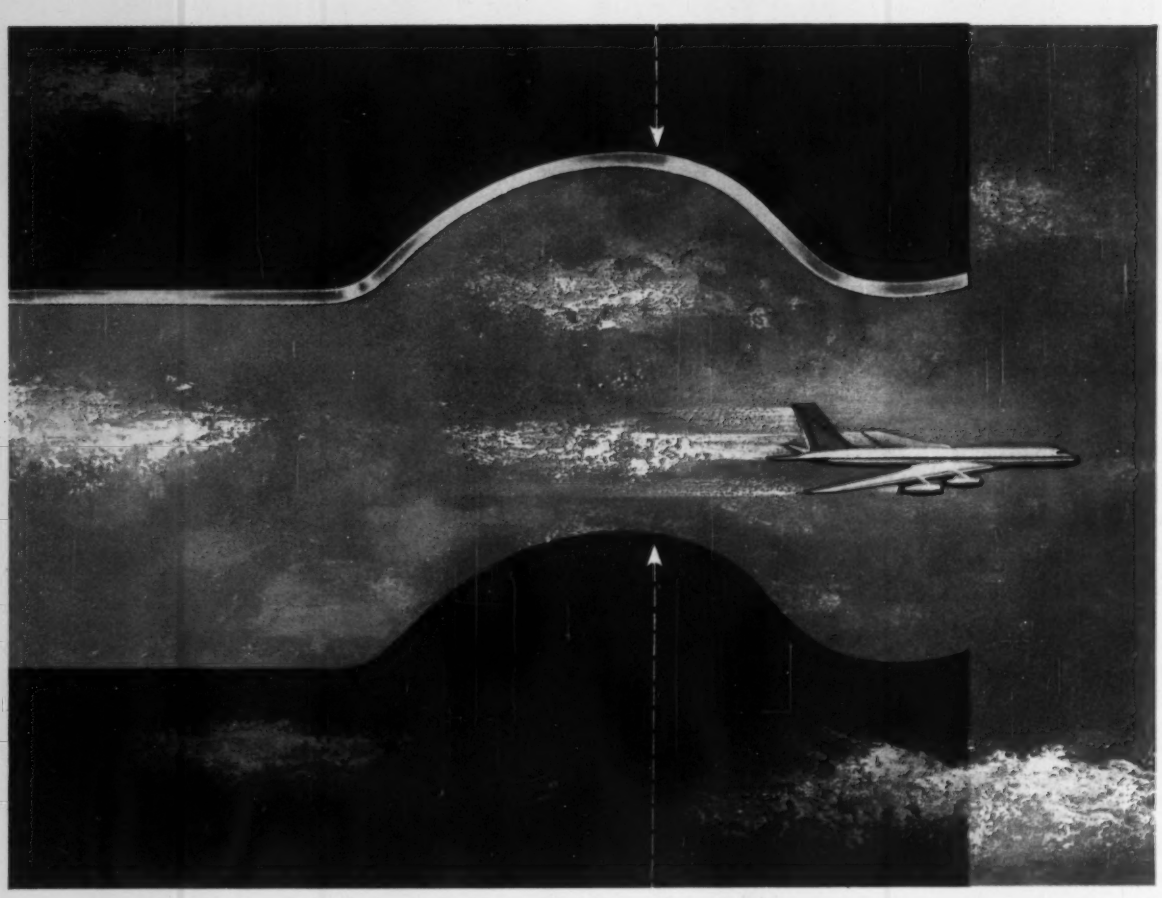
Final coat *of white epoxy resin is sprayed over gray mastic. Total thickness of coating is 23 mils on concrete, 16 mils on steel.*

New Ultra High Strength Steel

offers 7% higher strength than other low alloy steels

A3J 'Vigilante' *uses USS Strux in key landing gear parts. Each main gear must withstand loads that can exceed 100,000 lb.*

■ A new ultra high strength steel was recently announced by United States Steel Corp, Pittsburgh. Called "USS Strux," the steel can be forged, machined, and heat treated to the 280–300,000 psi tensile strength level. The steel develops about 7% more strength than other low alloy steels and can be used to reduce weight of



Want to save with plastic tools and dies?

Your EPON® RESIN tooling formulator can help you

Tools and dies made of tough but easy-to-handle Epon resin can save you up to two thirds in time, one third in cost! Your tooling resin formulator will show you how Epon resin formulations are saving time and money—*right now*—in applications such as:

High-temperature tooling: Metal-forming stretch dies that can operate at temperatures over 400° F.

Heated tools: Matched dies, with integral heating units, may be made with Epon resin formulations for rapid heat-curing of laminated plastic parts.

Long-lasting metal-forming tools: Castings made of formulated Epon resin, mounted in a crank press, showed no permanent deformation after 28,000 compression-shock cycles.

For tool and die applications, Epon resin formulations offer you the following important advantages:

Excellent tolerance control: Little machining and handwork are required to finish Epon resin tools because of the material's excellent dimensional stability and lack of shrinkage.

Outstanding strength: Jigs and fixtures with thin cross sections can be built from Epon resin-based formulations reinforced with glass cloth. The resulting laminate has high flexural strength and excellent dimensional stability.

Easy modification: Tools and fixtures made from Epon resins may be quickly and easily modified to incorporate design changes.

CONTACT YOUR TOOLING RESIN FORMULATOR

The combination of resin formulator's skill and application knowledge, backed by Shell Chemical's research and resin experience, has solved many important tooling problems for industry. For a list of experienced tooling resin formulators and additional technical information, write to:

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PLASTICS AND RESINS DIVISION
50 WEST 50th STREET, NEW YORK 20, NEW YORK

Central District	East Central District	Eastern District	Western District
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IN CANADA: Chemical Division, Shell Oil Company of Canada, Limited, Toronto

SHELL

For more information, turn to Reader Service card, circle No. 415

aircraft components.

USS Strux was developed to meet the continuing need for an ultra high strength steel with adequate ductility and notch toughness for critical applications such as aircraft landing gears. The material is available in the hot rolled or annealed condition in a full range of bar sizes and as billets or blooms.

Composition—The composition of USS Strux, in %, is: C 0.40-0.47, Mn 0.75-1.00, Si 0.50-0.80, Ni 0.60-0.90, Cr 0.80-1.05, Mo 0.45-0.60, V 0.01 min, B 0.0005 min.

Heat treatment—To develop a minimum of 280,000 psi tensile strength the recommended treatment is: normalize from 1600-1650 F, reheat to 1550 F and oil quench, temper in the range 450-550 F. Fig 1 shows the relationship between tempering temperature and mechanical properties. The yield strength - to - tensile strength ratio is shown in Fig 2. The steel can be annealed from 1500 F .

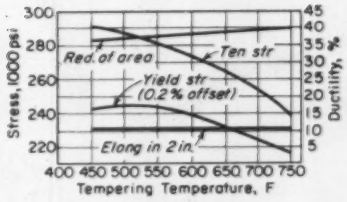


***Fig 1**—Effect of tempering temperature on tensile properties of USS Strux. Steel was normalized at 1600-1650 F and oil quenched from austenitizing temperature of 1550 F.*

Hardenability—The steel has sufficient hardenability to form martensite in sections exceeding 4 in. in dia.

For more information, circle No. 601

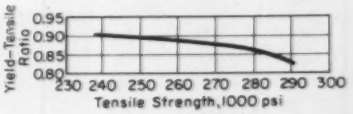


***Fig 2**—Yield-to-tensile ratio.*

90-10 Tantalum-Tungsten Alloy Forged in Air

■ An electron-beam-melted tantalum alloy containing 10% tungsten is as strong as tungsten up to 4500 F, more resistant to oxidation than tungsten, readily fabricable using conventional steelworking techniques, and ductile in the as-welded condition.

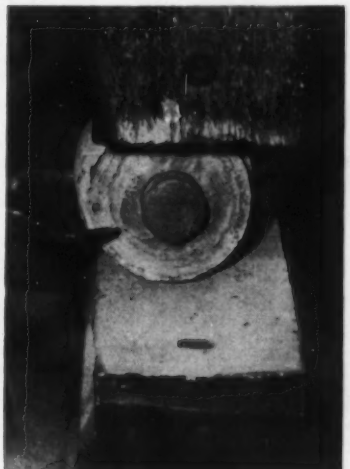
Following forging and surface clean-up (about 1/16 in.) the alloy can be reduced approximately 80% at room temperature to produce sheet material. Annealing at 2000 F in a resistance heated vacuum furnace after cold rolling restores ductility and allows further cold work

The electron-beam-melted alloy is available from Stauffer-Temescal Co., Richmond, Calif.

For more information, circle No. 602

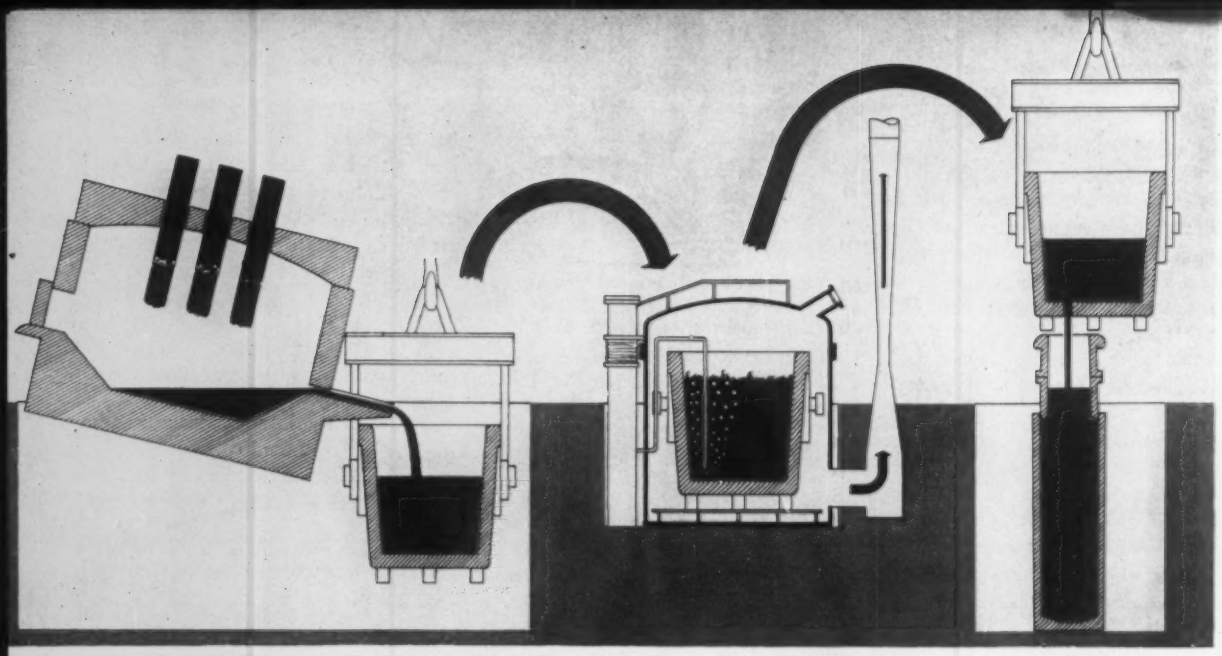
1 90-10 tantalum - tungsten alloy *is forged in air at 2000 F with only slight oxidation losses.*

2 Upset billet *has been forged into octagonal form.*



3 Partially shaped piece *is pierced with a specially hardened steel pin.*

4 Finished part *is rocket nozzle with a threaded retaining ring. Finish machining requires removal of approximately 1/16 in. of material.*



***Tapping (left)**—75,000-lb heat of nickel alloy steel is poured into ladle.* ***Degassing (center)**—Ladle of molten steel is placed inside vacuum degassing chamber. Four suction pumps create a high vacuum while helium is injected into melt. Hydrogen, oxygen and nitrogen boil out of melt. Total time in chamber is 15 min.* ***Pouring (right)**—Degassed steel pours smoothly into ingot mold.*

Steel Vacuum Degassed in the Ladle

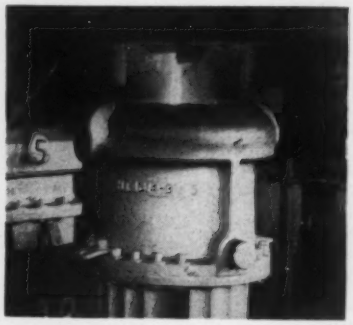
New method can be used in the foundry

■ The schematic diagram above shows the basic parts of the new vacuum degassing process developed by A. Finkl & Sons, 2011 N. Southport, Chicago 14. The process represents a practical foundry approach to the problem of removing gases entrapped in a steel melt. After the heat is degassed in the ladle, it can be poured into several molds—a feature important to foundries.

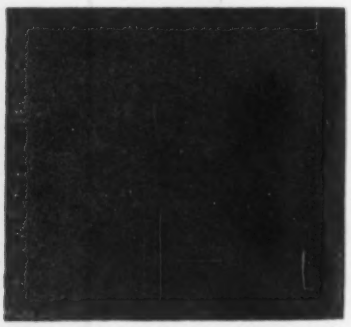
Vacuum degassing produces sounder ingots which can be forged into cleaner products. The accompanying macrophotograph of a 14-in. bloom forged from a 23-in. ingot shows the high quality of the product. A further advantage of vacuum degassing is that it increases ductility of the product. Elongation has been increased by approximately 40% and reduction of area by approximately 80%. Gas content of the steel is reduced about 60%.

One of the problems that had to be overcome in obtaining a practical ladle degassing method was how to increase the speed of gas diffusion through the liquid metal. Normally, since degassing must take place through the surface of the melt, it is not commercially practical to attempt to remove the gases from a ladle sitting in a vacuum chamber. After the gases near the surface are removed, the remaining gases would take too long to travel through the molten metal to be removed economically. Finkl engineers speeded up the diffusion process by injecting helium gas into the ladle in order to increase circulation, expose more of the steel surface to the vacuum, and adsorb the hydrogen, nitrogen and oxygen molecules on the helium bubbles.

For more information, circle No. 603



***Smooth, tight stream** is achieved in pouring the ladle degassed steel. Tightness is a measure of gas removal.*

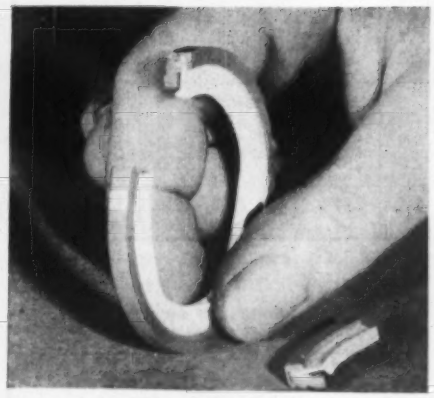


***Macroetched** center section of 14-in. bloom forged from a 23-in. ingot. The cross section, shown half size, is extremely clean and shows no evidence of inclusions.*

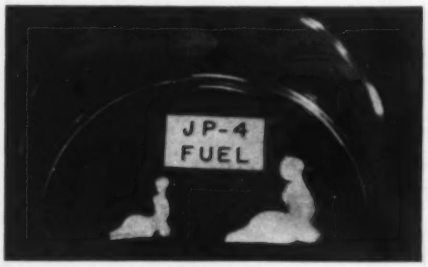
What's New in Fluorosilicone Rubbers?

Versatility, say the authors. With the development of new compounds and a masterbatch, you can now specify a wide range of properties in a variety of forms in this fluid-resistant silicone rubber.

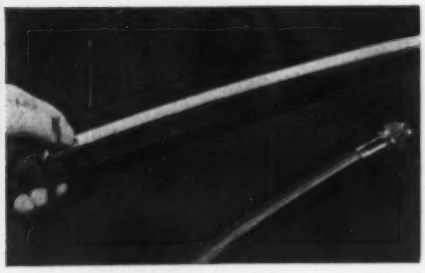
by R. S. Naegele and T. D. Talcott, *Dow Corning Corp.*



Moldings, *until now the only practical forming method, are exemplified by this oil resistant seal shown in its retaining ring.*



Extrusions *of fluorosilicone rubber in complicated profiles are now practical; the part at left is fluorosilicone, the swollen one at right a general purpose silicone rubber.*



Calendered *on cloth, fluorosilicone rubber provides a strong, fluid and heat resistant flexible tubing.*

■ Since 1956 only one fluorosilicone rubber has been available—Silastic LS 53. A Shore A55 durometer compound, it has been well accepted for its excellent solvent and oil resistance over a temperature range of –80 to 500 F. Its use has been limited, however, in that 1) it is a single compound whose properties cannot be altered greatly to meet specific design needs, 2) processability is such that molding is virtually the only satisfactory forming method used, and 3) its high cost (price reduction effective this month brings cost down to $12 per lb) has restricted it to critical high or low temperature uses where maximum resistance to fuels, oils and solvents is mandatory.

Several recent developments have helped to overcome these limitations. Briefly they are:

1. *Improved processing compound*—A new 60-durometer compound, Silastic LS 63, can be easily formed by molding, extrusion, calendering, sponging, solution coating and cloth coating.

2. *Fluorosilicone masterbatch*—Availability of a masterbatch, Silastic LS-422, means that the engineer can specify his design

TABLE 1—TYPICAL PROPERTIES OF FLUOROSILICONE COMPOUNDS[a]

Type →		Silastic LS-53[b]	Silastic LS-63[c]	Compounds Prepared from Silastic LS-422 Base		
				Low Durometer[d]	High Durometer[e]	Lower Cost[f]
	ASTM					
Specific Gravity		1.4	1.45	1.38	1.46	1.52-1.77
Hardness (Shore A)	D676	50-65	55-65	35	80	70-75
Ten Str, psi	D412	800-1000	800-1050	900	1000	500-750
Elongation, %	D412	150-170	150-170	250	140	120-130
Tear Str (die B), lb/in.	D624	60	70	50	110	80
Compression Set (22 hr, 300 F), %	D395	22	23	15	55	20
Brittle Point, F	D746	−90	−90	−90	−90	−90
Stiffening Temp, F[g]	D746	−78	−78	−78	−78	−78
Solvent Resistance[h]						
ASTM Fuel B (24 hr, 77 F)		−6, +20	−10, +21	−9, +30,	−15, +23	−9 to −10, +17 to +21
ASTM No. 3 Oil (77 hr, 300 F)		−6, +4	−2, +5	−9, +3	−9, +4	−4 to −18, +3 to +5
Recommended Fabricating Methods[i]		M	MEC	MEC	ME	MEC
Pound-Volume Cost[j], $		16.80	17.40	18.50	16.25	12.40 to 15.00

[a] Data indicate typical values, and in some cases typical ranges, obtainable; data should not be used for specification.
[b] Oven cured 24 hr at 300 F.
[c] Oven cured 8 hr at 400 F.
[d] Vulcanized with no additional filler.
[e] 20 parts Cab-O-Sil, 0.8 parts Mapico Red MS-7.
[f] Range covers 2 typical highly filled compounds; filling reduces cost.
[g] Temperature at which Young's modulus reaches 10,000 psi.
[h] First value is durometer change in points; second value is volume change in %.
[i] Code: M=molding, E=extruding, C=calendering.
[j] Cost per lb × specific gravity.

TABLE 2—PROPERTIES OF BLENDS

Type of General Purpose Silicone Rubber →	50-Durometer General Purpose[a]					70-Durometer General Purpose[b]				Low Compression Set Compound[c]			
Composition of Blend: % Fluorosilicone (LS-53)	100	75	50	25	0	75	50	25	0	75	50	25	0
Composition of Blend: General Purpose	0	25	50	75	100	25	50	75	100	25	50	75	100
Original (24 hr, 300 F cure)													
Specific Gravity	1.41	1.35	1.30	1.25	1.20	1.36	1.32	1.28	1.24	1.36	1.31	1.27	1.23
Hardness (Shore A)	58	57	57	55	53	63	65	70	73	60	62	61	58
Tensile Strength, psi	890	1030	1100	970	1030	1130	1150	1150	1120	830	880	730	680
Elongation, %	160	210	300	350	440	210	260	330	360	160	190	200	220
Tear Str, lb/in	41	51	54	77	67	56	61	78	100	47	55	63	51
Compr Set (22 hr, 300 F), %	24	23	29	33	39	30	43	59	66	18	15	12	17
After Aging 70 hr, 450 F													
Hardness (Shore A)	50	57	56	57	54	60	66	72	76	58	60	60	61
Tensile Strength, psi	830	880	970	830	930	960	986	920	970	800	830	680	640
Elongation, %	160	200	260	260	300	200	220	230	250	150	150	150	140
Cost, $/lb-vol	16.92	13.24	9.92	6.80	3.90	13.24	9.97	6.81	3.84	13.33	9.96	6.99	3.94

[a]Silastic 50. [b]Silastic 80. [c]Silastic S-2096U.

TABLE 3—EFFECTS OF FLUIDS ON RTV FLUOROSILICONE RUBBER[a]

Fluid →	JP-4 (7 Days, 77 F)	ASTM No. 3 Oil		Turbo Oil No. 15 3 Days, 350 F
		3 Days, 300 F	3 Days, 400 F	
Hardness Change, pts	−4	−6	−11	−10
Tensile Str Change, %	−42	−19	−40	−37
Elongation Change, %	−48	−18	−2	−18
Volume Change, %	−20	+2	+4	+5

[a]All specimens vulcanized 7 days at 77 F.

TABLE 4—ADHESION OF RTV FLUORO-SILICONE TO ALUMINUM[a]

Test Condition	Peel Strength, lb/in.
Control	13.5
Effects of Heat (24 hr)	
300 F	12.0
390 F	11.0
480 F	9.0
Effects of Fluid	
Water (24 hr)	13.5
Turbo Oil No. 15 (70 hr at 250 F)	8.0
ASTM No. 3 Oil	
70 Hr at 300 F	9.5
70 Hr at 400 F	7.0

[a]All specimens vulcanized 7 days at 77 F.

requirements, and his rubber processor can compound specifically to meet these requirements (within the range of inherent properties of the material).

3. *Cost reduction by blending*—Where maximum fluid resistance is not required, resistance intermediate between that of a fluorosilicone and other silicone rubbers can be obtained at a substantial cost reduction by blending fluorosilicone with general purpose silicone rubbers.

4. *RTV fluorosilicone*—Still in the research stages, a room temperature vulcanizing fluorosilicone rubber promises to provide excellent fluid resistance without the need for heat curing.

Variety of compounds

Table 1 lists typical properties of LS-53, the new LS-63, and three typical compounds formulated from the new masterbatch. LS-63 is a 60-durometer stock, but otherwise is quite similar to the older LS-53 in properties. However, it can be molded, extruded or calendered.

The "Low Durometer" compound formulated from the masterbatch shows typical properties of the softest compound available in fluorosilicone rubbers. It also has the best compression set resistance, the poorest tear strength, and the highest volume change in ASTM Reference Fuel B. Price is highest because it has the least filler.

The "High Durometer" compound illustrates the range of hardnesses obtainable by altering formulation. In general higher modulus and higher tear strengths are obtained at the higher filler loadings, along with improved solvent resistance.

Where cost and fluid resistance are both critical, but mechanical properties can be sacrificed, high filler loading can result in a minimum cost compound, i.e., $12.40 to $15 per lb-volume (cost per lb × specific gravity). Values shown in the column headed "Lower Cost" indicate typical properties obtainable by high filling. Solvent and fuel resistance remain excellent. (Blending to reduce costs, but at a sacrifice in fluid resistance, is discussed in a subsequent section.)

In general, fluorosilicone rubbers have electrical insulating properties similar to those of other silicone rubbers, although usually slightly inferior. Dielectric strength is about 350 v per mil. and remains unchanged after 24 hr in water. Dielectric constant

is quite high, averaging about 7.4 at 100 cps, and 6.2 at 10^6 cps. These values are increased to 8.0 and 6.4 respectively by 24-hr immersion in water. Volume resistivity is 1.0×10^{13} ohm-cm and drops to 2.0×10^{12} after 24 hr in water. Dissipation factor is 0.07 at 100 cps; 0.04 at 10^6 cps. (These values were obtained on 0.070-in. slabs of LS 63 molded 5 min at 260 F, then oven cured 24 hr at 392 F.)

Lower cost blends

Some fluid exposure—e.g., exposure to splash or fumes only—are not severe enough to justify the cost of a straight fluorosilicone rubber compound. Where the required fluid resistance is intermediate between that of fluorosilicone and general purpose silicone rubbers, varying degrees of resistance at intermediate costs can be obtained by blending.

Before deciding on the type of elastomer needed, remember that though fluorosilicone rubber is superior to silicone rubber in resistance to most fuels, oils and solvents, there are exceptions. In acetone, certain other ketones, and in phosphate esters, regular silicone rubbers are actually more resistant than fluorosilicones.

Table 2 shows mechanical properties and costs of blends of different proportions of LS-53 and three general purpose silicone rubbers. The curves below show the effect of changing proportions of fluorosilicone and general purpose silicone rubbers on fluid resistance. Although volume change is not a precise measure of the fluid resistance of an elastomer, it does provide an indication of the magnitude of the effect of a fluid. For any specific type of service, actual tests in the fluid must be conducted.

An additional benefit obtainable by blending is the opportunity to develop a compound with optimum resistance to two different fluids. For example, if the compound must resist exposure to both Turbo Oil No. 15 and Skydrol 500, the curves show that optimum resistance to both fluids is obtained by a blend of about 50:50 fluorosilicone and general purpose silicone rubber.

Room temperature cure promised

The room temperature vulcanizing silicone rubber still under development (expected to be available in early 1961) is a one-component system applied in a pastelike consistency from a calking gun. The material vulcanizes in three days; maximum physical properties are obtained in seven days.

Initial data indicate that physical properties of the RTV will be relatively low (i.e., a 36-durometer stock has a tensile strength of about 380 psi, with 220% elongation), but property retention after exposure to heat will be good. The preliminary data in Table 3 show how physical properties are affected by immersion in fuels and lubricants at different temperatures.

RTV fluorosilicone rubber appears to provide excellent adhesion to a variety of metals. Table 4 shows the effects of heat and various liquids on a bond between the rubber and aluminum. All failures are cohesive, indicating that the bond to metal is stronger than the elastomer itself. Adhesive strengths to other metals are essentially the same.

For more information, circle No. 604

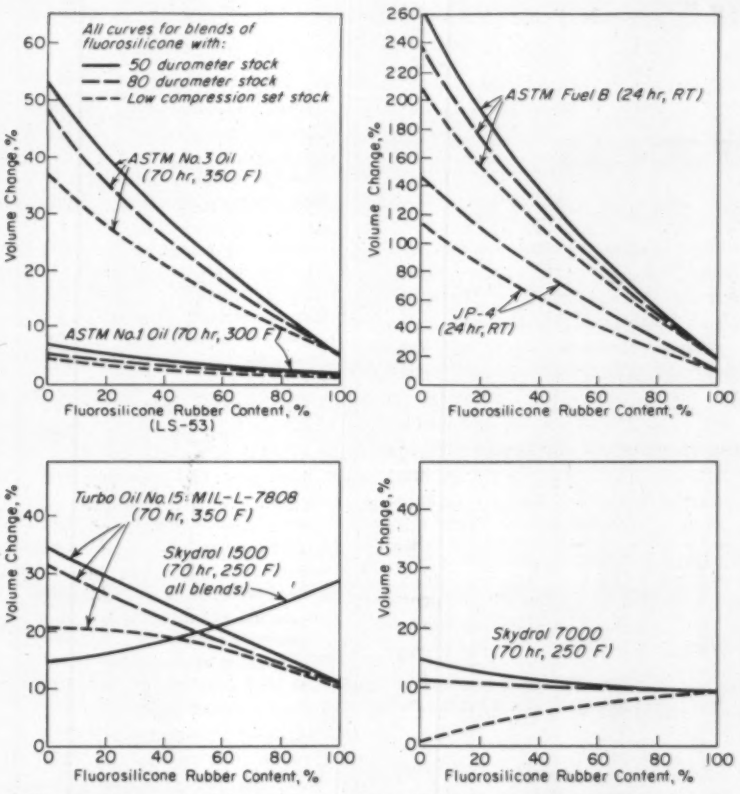
Other Articles on Fluorosilicone Rubber

New Heat and Solvent Resistant Elastomer, *Materials & Methods*, Nov '56, p 163.

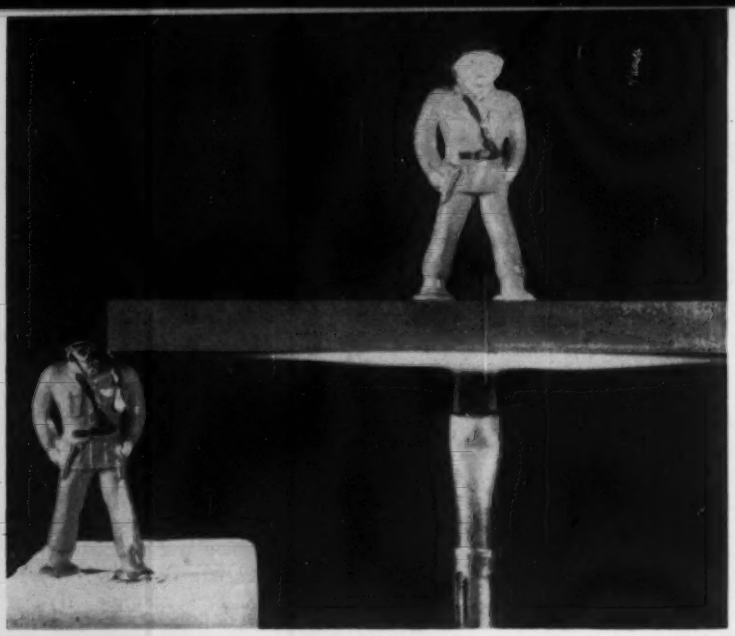
Selecting Silicone Rubbers, *Materials & Methods*, June '57, p 114.

The Fluoro-Elastomers: Latest Weapon Against Heat and Fluids, M/DE, July '57, p 90.

Seven Silicone Rubbers Are Easy to Process, M/DE, Sept '59, p 134.


All curves for blends of fluorosilicone with:
50 durometer stock
80 durometer stock
Low compression set stock
ASTM No.3 Oil (70 hr, 350 F)
ASTM No.1 Oil (70 hr, 300 F)
ASTM Fuel B (24 hr, RT)
JP-4 (24 hr, RT)
Turbo Oil No.15: MIL-L-7808 (70 hr, 350 F)
Skydrol 1500 (70 hr, 250 F) all blends)
Skydrol 7000 (70 hr, 250 F)
Volume Change, %
Fluorosilicone Rubber Content, % (LS-53)

Volume change *of differing proportions of blends of fluorosilicone and three general purpose silicone rubbers. (General purpose compounds used to blend with LS-53 Silastic 50, 80, and S-2096.)*



***One-way heat flow** is shown graphically by melted head on lead soldier at left. Much lower thermal conductivity perpendicular to face of Pyrographite permits soldier on top to remain relatively unaffected.*

Oriented Graphite Produced by Commercial Process

■ Oriented graphite, which provides strongly anisotropic thermal and electrical conductivity characteristics, can now be produced in commercial quantities. The material has thermal and electrical conductivities several orders of magnitude higher in the plane parallel to the surface than at right angles to the surface.

Other characteristics of the material are high density and impermeability to gases. Properties of the material, called Pyrographite, are compared with those of several other materials in an accompanying table.

Made by a process developed by Raytheon Co., Waltham 54, Mass., the material is expected to be useful for applications in rockets and missiles, electrical and electronic systems, and nuclear reactors.

TYPICAL PROPERTIES OF PYROGRAPHITE VS OTHER MATERIALS

Property	Pyrographite	Graphite	Alumina (Al_2O_3)	Copper	Tungsten
Subl or Melt. Pt, F	6650	6650	3870	1980	6100
Density, lb/cu ft	112.3-138.5	99.8-124.8	248.4	555.4	1204
Ten Str, 1000 psi	15-20	2-4	30	60-70	120
Spec Heat, Btu/lb/°F	0.232	0.17	0.184	10.0921	0.034
Ther Cond, Btu/hr/sq ft/°F/ft	a = 92.5-225.4; c = 1.16-2.02[a]	109.2	17.3	225	98.3
Spectral Emissivity	0.81-0.90	—	0.22-0.90	0.10	0.43
Elec Res, ohm-cm	a = 200-250 x 10^{-6}; c = 0.25	800 x 10^{-6}	10^{16}-10^{18}	1.77 x 10^{-6}	5.51 x 10^{-6}
Hardness (Mohs)	a = 1; c = 4.5	0.5-1	9	2.5-3	—
Coef of Ther Exp, per °F	0.37 x 10^{-6}	4.37 x 10^{-6}	—	9.3 x 10^{-6}	2.4 x 6^{-6}
Strength/Density (approx), 1000 psi	10	1.34	7.55	7.3	6.2

[a]Absolute value depends on density.

Thermal and electrical properties

Graphite, which sublimes at 6350 F, has the highest heat resistance of any elemental material. But the oriented structure of Pyrographite combines this high temperature resistance with highly anisotropic heat transfer characteristics.

Fig 1 shows the conductivity

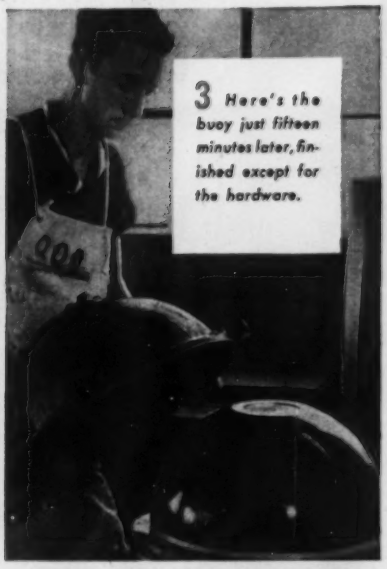
continued on p 170

MORE WHAT'S NEW IN MATERIALS

Fluoro-elastomer resists heat, solvents 172
Lacquers for plastics 174
Brazing alloy for stainless honeycomb ... 176
Duplex electroplate 176
Resistance alloy is corrosion resistant 178
Coatings applied by plasma arc technique 180
Metals cleaned, primed, painted in one unit 182
Synthetic latex 184
Permanent magnet with high energy value 186
Zone melting boron 188
Polyethylene clarity increased by annealing 188
Control improves resistance spot welds 190
Ceramic cylinders 194
Magnesium sheet can be bent cold 194
Diamonds tailored for grinding, polishing 196
Wood grain texture for molded plastics 198
Large plywood panels ... 200
Synthetic mica paper 200
Clear acrylic resin 202
Wood hardboard resists moisture 204
Other news 206

"POLYLITE resins are indispensable to production of our unique foam buoy"

— says Lester Hegstad, Hanson Equipment Company



"RCI POLYLITE polyester resins have helped us obtain exactly the properties we want in our Skipperline Buoy," says Lester Hegstad, Vice President in Charge of Engineering, Hanson Equipment Company, Beloit, Wisconsin.

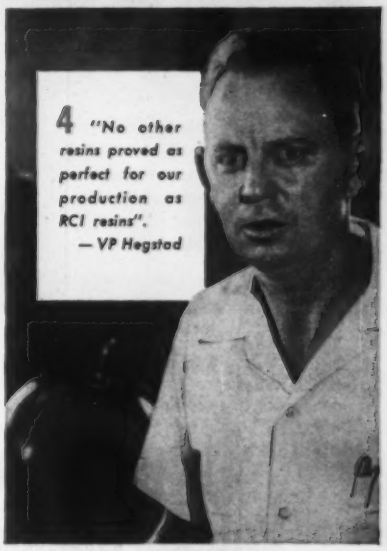
The buoys are constructed of polyurethane foam and a "skin" of reinforced plastic. The foam fills the body of the buoy and makes it lighter and more buoyant than wood or cork, as well as impervious to rot. The exterior is resistant to rot, unharmed by salt water, and won't chip, peel or require painting.

The foam core of the buoy is prepared by blending the POLYLITE ingredients and pouring them as a liquid into the mold which has been lined with the reinforced plastic "skin." Foaming and curing take place rapidly and at room temperature. The result is a hard, rigid foam with a high strength-to-density ratio and an exceptionally uniform structure of closed cells.

The "skin" is made from glass fiber cloth and two other POLYLITE resins — a colored gel coat and a bonding resin.

The Hanson Company also uses RCI resins in its manufacture of reinforced plastic tanks and boats. In every case the company has found that no other resins perform as well as the RCI line.

Perhaps there's a POLYLITE resin that can improve your products or production technique. Your REICHHOLD representative will be glad to discuss it with you.



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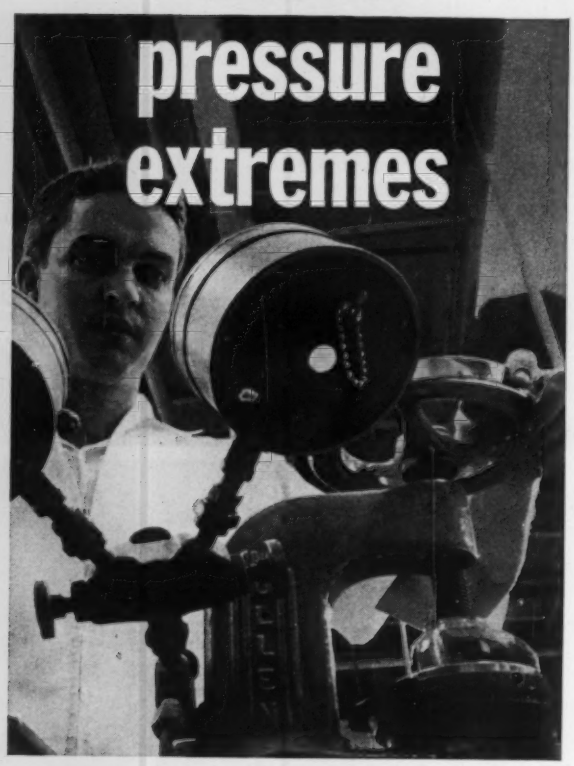

The Mullen Burst Test, being run here at our lab in Buena Vista, Virgina, is the yardstick to determine maximum resistance to burst to make certain the material conforms to specifications.

with Reeves Vulcan Diaphragms

One of the numerous inspections in our system of quality control is the Mullen Burst Test. This inspection is used on every roll of coated fabric before it is shipped or made into diaphragms.

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For more information, turn to Reader Service card, circle No. 336

Polymethylstyrene discontinued

To the Editor:

We are very interested in polymethylstyrene described in your July '59 issue. We have attempted to find a source of supply for this material and have not been successful. We learned that American Cyanamid Co. previously manufactured this item. However, they have discontinued its manufacture and were unable to refer us to a current source of supply for this material.

We would appreciate your assistance in finding this information.

H. J. BROWN
Administrative Assistant
University of Chicago
Chicago

American Cyanamid was the sole producer of this material.

Material to fight traffic noise?

To the Editor:

Please advise if there is a material in drape, curtain or venetian blind form that can be used in a home to keep out heavy truck traffic noise.

The front of the house faces the main street and is mostly glass double pane, but the noise comes through and is bothersome during sleeping time. Can you help?

JAY MORGAN
Morgan-Francis Co., Inc.
Stratford, Conn.

A flexible urethane foam material might solve the problem. We suggest contacting Mobay Chemical Co., 1815 Washington Rd., Pittsburgh 34.

Schizophrenic scales

To the Editor:

On p 94 of your Feb '59 issue the authors McMahone, Birdsall, Johnson and Camilli in the article "Polyester Film—How Long Does It Last?" show two graphs in which the useful service life of Mylar polyester sheet is plotted against the service temperature with relative humidity as an additional parameter.

Though the use of a logarithmic time ordinate and a linear temperature abscissa is fully justified and understood, it is confusing to read the temperature scale. At equidistant points you find in the first graph 85, 105, 120, 140, 160, 175, and 195 F; in the second graph you find 105, 120, 140, 160, 175, 195 and 212 F.

Is this the outcome of an originally used Centigrade scale which was converted into Fahrenheit and then rounded off?

If so it would just be another occasion to comment on our almost schizophrenic situation when

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For further information, see your A-L sales engineer or write for the new technical booklet, "AM 350 and AM 355." *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.* 892

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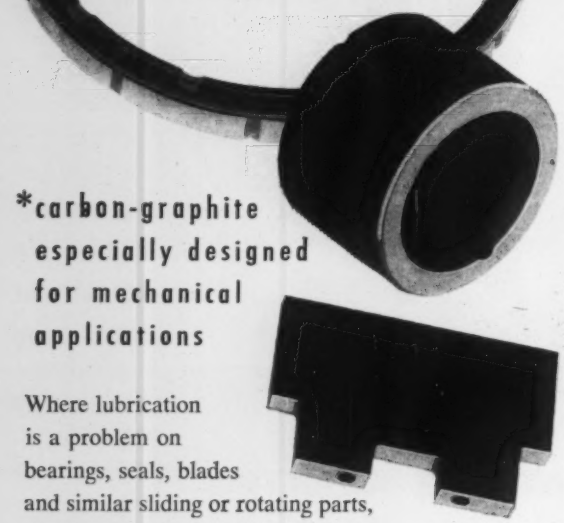

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working or having to work with two systems of weights, measures and temperatures, i.e., the metric and the British systems, and the many unhappy hybrids of the two.

ALBERT HARTIG
Research Engineer
Pfaff Industrial Sewing Machine Corp.
New York City

Mr. Hartig is correct in assuming that the somewhat illogical temperature breakdown in our Feb '59 polyester film article resulted from direct conversion from the Centigrade scale. We agree that the results of the conversion can be somewhat confusing when comparing the two graphs in general. However, we feel that the desired result is easily obtainable when using the two graphs to pick off maximum service life for a given thickness at a given service temperature. From the standpoint of editorial style, we have settled on the British system primarily because we find that the vast majority of our readers are most familiar with it. We would be more than happy to go along with any international system that would be universally agreed upon.

Damping and brittleness

To the Editor:

I would like to comment briefly on the "damping and brittleness" letters in M/DE, such as the Apr '59 letter by Mr. A. C. Strother.

Considerable confusion exists on the subject of material damping because of its dependence upon such factors as grain size, temperature, frequency, stress level, mode of stressing and coldworking. However, any relationship between damping and brittleness is indeed remote. Cast iron is brittle but exhibits high damping capacity, whereas ductile copper exhibits considerably lower damping (at least for frequencies between 20 and 1000 cps). It is therefore difficult to see how damping and brittleness can be placed at opposite ends of the same scale.

Similarly, any direct relationship between hardness and damping is obscure. A number of soft materials such as lead exhibit high damping capacity, but hard materials such as nickel also evidence high damping. In some instances, heat treatment has very little effect upon damping, while impact loading a well-annealed metal will produce an immediate increase in its damping capacity. Perhaps a better explanation of damping can be obtained by reference to the quantity and mobility of dislocations.

HERBERT L. MILLIGAN
Bellevue, Wash.

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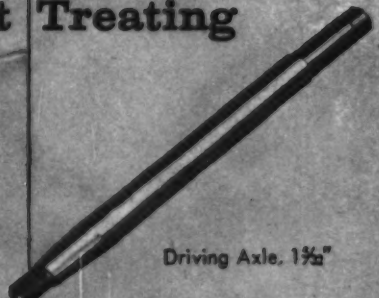
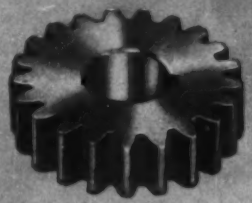
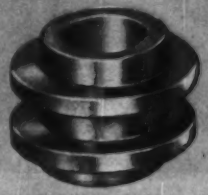

Driving Axle, 1 3/32"

Shifting Shaft, ¾"


Reverse Pinion, 3"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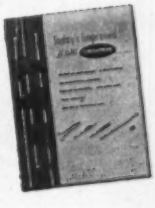

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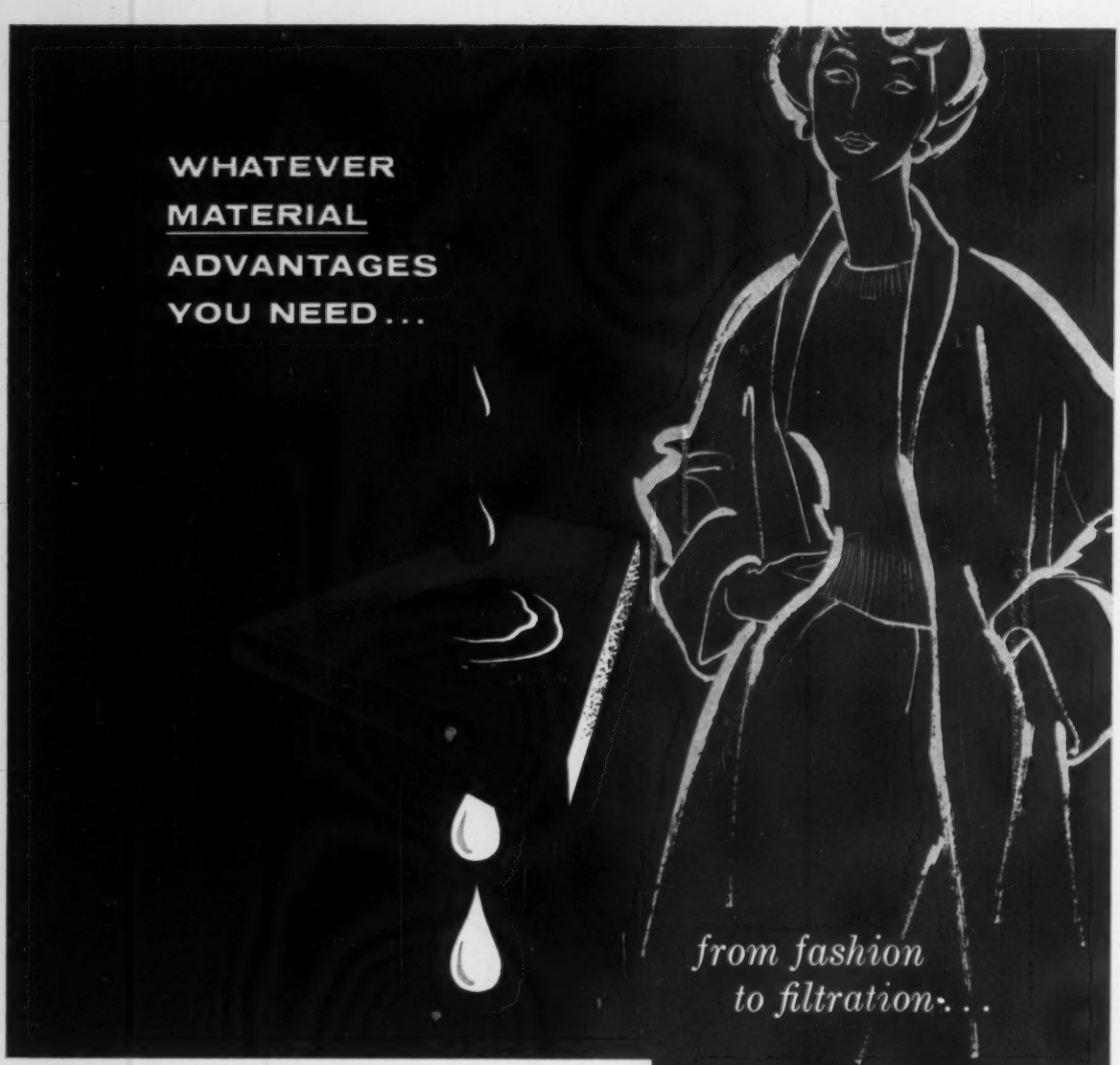

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PRICES & SUPPLY

...AT A GLANCE

Production of all types of engineering materials reached new highs in 1959, according to year-end reports now being released. For example, in metals . . .

Aluminum production set a new record of 1.95 million tons, 25% over the 1.57 million tons of 1958 and 16% over the previous peak of 1.68 million tons in 1956. Steel production reached 93,436,813 net tons, about 8,000,000 tons more than in 1958. Titanium mill products totalled 3100 tons, a 20% increase over 1958. And in nonmetallics . . .

Plastics production was up 25% last year to 5,600,000,000 lb, compared to 4,518,000,000 lb produced in 1958. Polyethylene and vinyl production passed the one billion pound mark for the first time in the history of the plastics industry. Synthetic rubber production reached 1,300,000 long tons, compared to a previous record of 1,118,173 long tons in 1957.

Steel prices are not likely to go up in the 'immediate future,' say industry and government leaders. Stable prices will help steel producers hold the line against competing materials such as aluminum, and against foreign steel imports. However, a price increase may come when pay increases go into effect next December. At that time labor costs will increase about 3.75%.

Price of Delrin acetal resin has dropped to 88¢ per lb—down 7¢ per lb from a previous price of 95¢ per lb in truckload quantities, according to an announcement from Du Pont. The resin is now in commercial production.

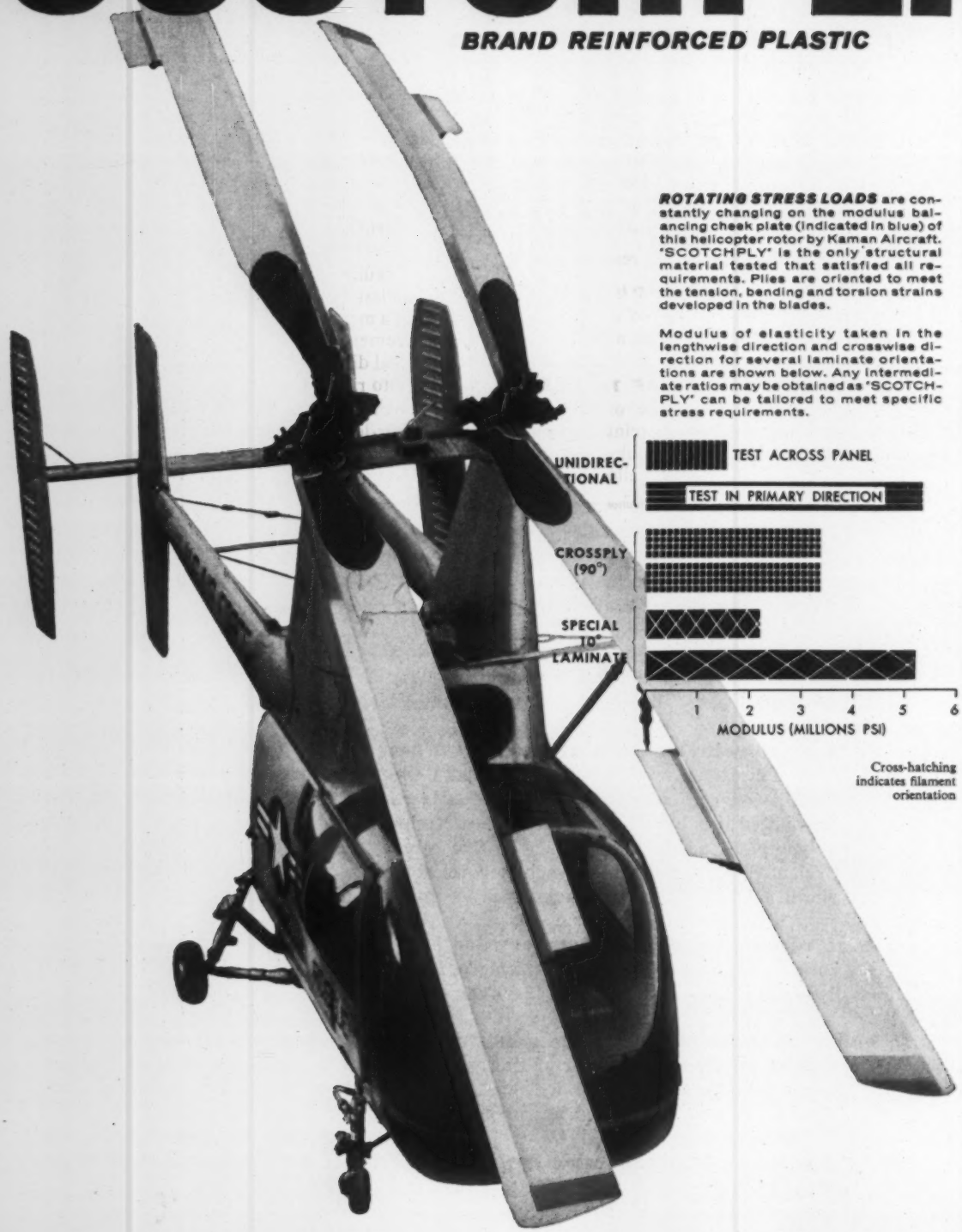
Price of polyethylene has dropped to a new low of 32½¢ per lb in carload lots. Price cuts were made by Koppers, Spencer Chemical and Union Carbide Plastics on conventional polyethylene. Meanwhile, Goodrich-Gulf Chemicals, Inc. announced it is building a plant at Port Neches, Tex. to produce a new high density polyethylene not currently made in this country. Based on Ziegler chemistry, the "oriented" material will have better resistance to heat and stress cracking than the usual high density polyethylene, according to the company.

Price reductions on tantalum powder have been announced by Fansteel Metallurgical Corp. and Kawecki Chemical Co. Fansteel's new price is $30 per lb in 5000-lb lots, down 25%—Kawecki's, $49.80 per lb in 200-lb lots, down 15%.

A new urethane fiber with the generic name 'spandex' will probably be in production by the third quarter of this year. Du Pont is building a plant at Waynesboro, Va. to make the fiber which it calls Lycra. The fiber will be aimed at many of the jobs now performed by rubber thread. Other companies actively interested in spandex fibers include U. S. Rubber Co. which calls its fiber Vyrene, and Firestone Rubber and Latex Products Co. Price of Du Pont's new fiber ranges from $4.75 per lb for 560-denier to $9.80 per lb for 70-denier fiber.

SCOTCHPLY®

BRAND REINFORCED PLASTIC



ROTATING STRESS LOADS **are constantly changing on the modulus balancing cheek plate (indicated in blue) of this helicopter rotor by Kaman Aircraft. "SCOTCHPLY" is the only structural material tested that satisfied all requirements. Plies are oriented to meet the tension, bending and torsion strains developed in the blades.**

Modulus of elasticity taken in the lengthwise direction and crosswise direction for several laminate orientations are shown below. Any intermediate ratios may be obtained as "SCOTCHPLY" can be tailored to meet specific stress requirements.

Cross-hatching indicates filament orientation

STRENGTH-TO-WEIGHT RATIO TOPS ALL STRUCTURAL MATERIALS

Strength/weight and other exclusive properties result from customized orientation of continuous, non-woven glass filaments*

What's the big difference between "SCOTCHPLY" and other pre-impregnated reinforced plastics? Only "SCOTCHPLY" BRAND Reinforced Plastic has continuous, non-woven glass filament* reinforcement.

Here are the superior properties that result:

★ ***UNMATCHED INDIVIDUAL PLY STRENGTH***—each ply consists of *continuous straight* filaments in parallel alignment, not crimped or woven.

★ ***HIGHEST DEGREE OF TAILORABILITY***—individual plies may be oriented to meet specific stress requirements; reinforcement (weight and bulk) is not wasted in directions or regions of low stress. This *degree* of tailorability is not possible with other reinforced plastics using woven cloth or short strand reinforcement.

This duo of exclusive advantages combines to give "SCOTCHPLY" an unequalled strength-to-weight ratio and superior fatigue properties.

Sold in uncured rolls or sheets, "SCOTCHPLY" Reinforced Plastic is a moldable, laminated plastic consisting of a mechanically controlled ratio of resin to reinforcement*. Heat and low pressure in matched metal dies, vacuum or pressure-bag molding cure it into rigid form.

For complete information and technical service, write on your letterhead to Dept. XAB-20. Reinforced Plastics Division, 3M Co., 1210 University Ave., St. Paul 4, Minn.

**Other available filaments: nylon, asbestos and other ablation materials. Epoxy, phenolic and other resin systems are available.*

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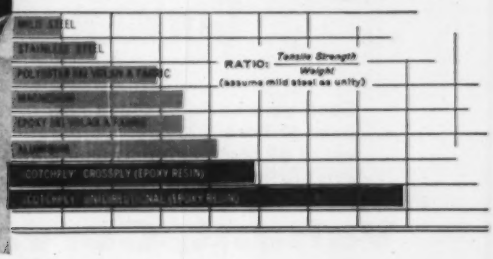
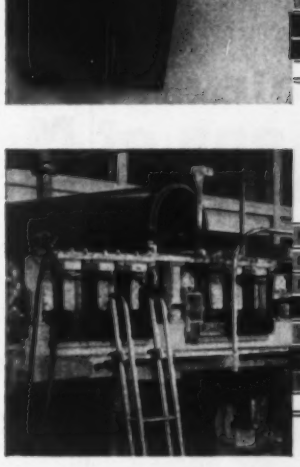
EXTREMELY HIGH TENSILE STRENGTH and light weight are essential in this battery case by Prewitt Aircraft for a classified missile. By proper orientation of reinforcing filaments, "SCOTCHPLY" provides maximum strength where strength is needed to withstand tremendous acceleration loads.

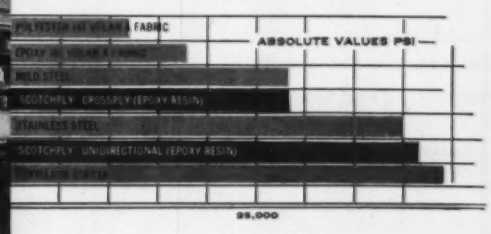
Tensile strength-weight ratios





FLEXURAL FATIGUE failure of metal Fourdrinier springs resulted in costly breakdowns on this paper machine manufactured by Rice Barton Corporation. Now Fourdrinier springs of "SCOTCHPLY"—tailored to the application—do the job.

Flexural-fatigue strength @ 2 x 10⁶ cycles



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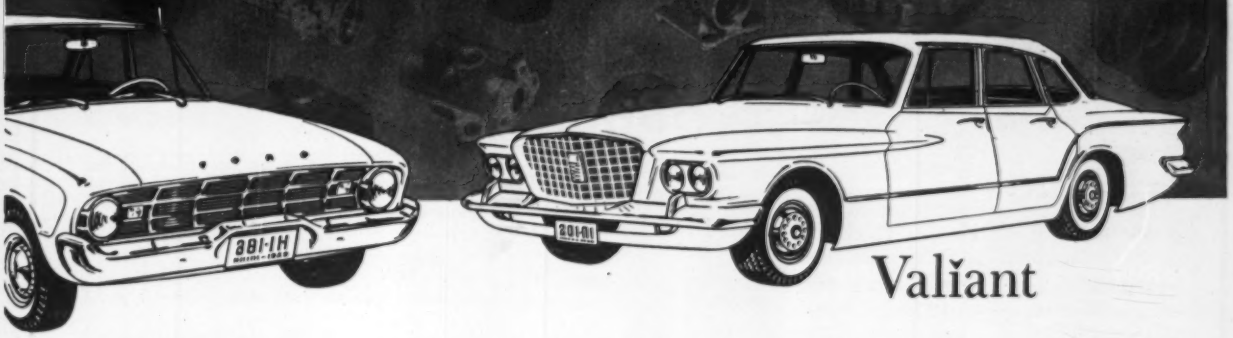

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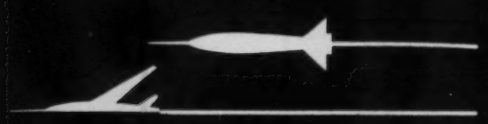

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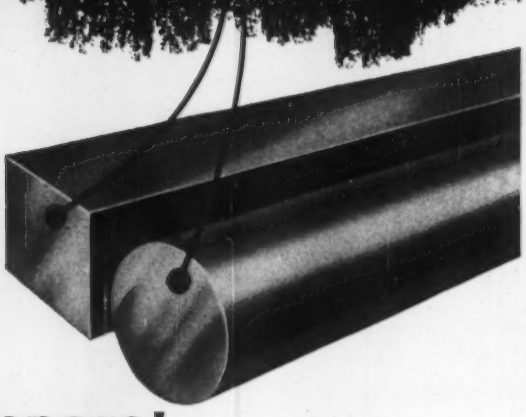

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Elongation %	4	8	2.5	8
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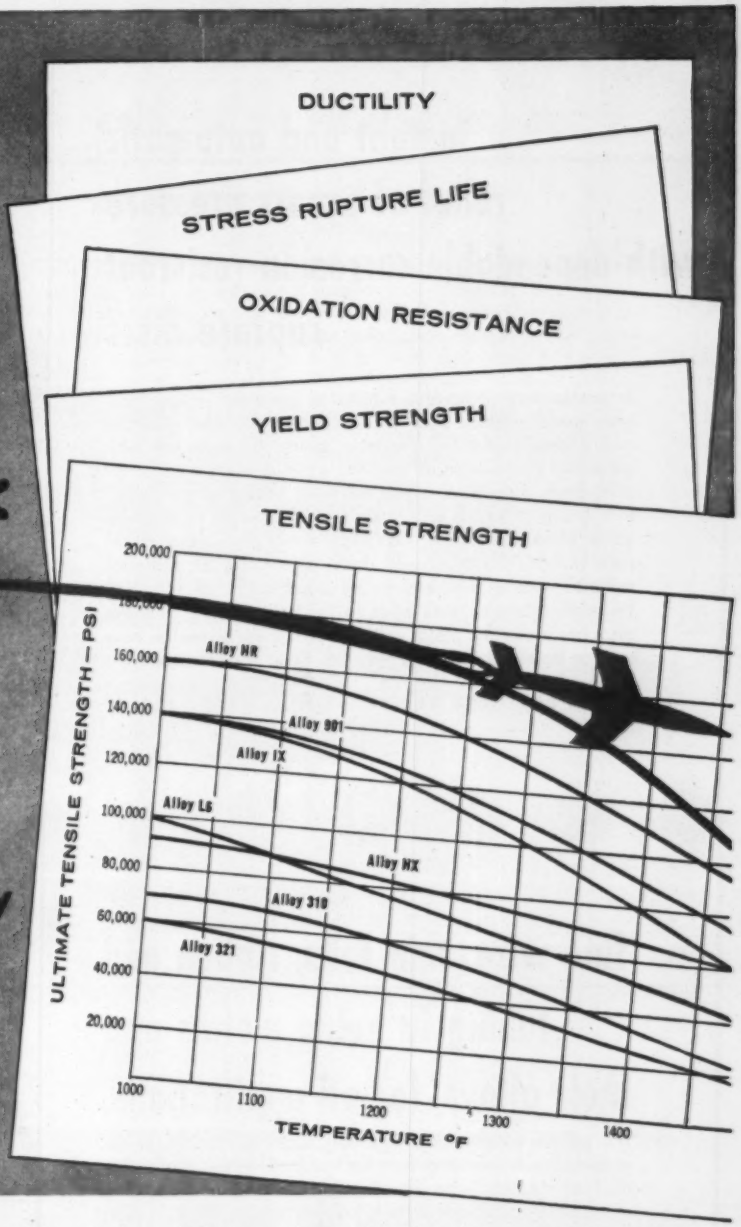

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Cannon-Muskegon offers René 41 in standard 36″x 96″ sheets .015″ to .125″ thick, in smaller sizes down to .010″, in bar stock up to 3″ in diameter... foil down to .001 in thickness... and fine wire only .0015 in diameter.

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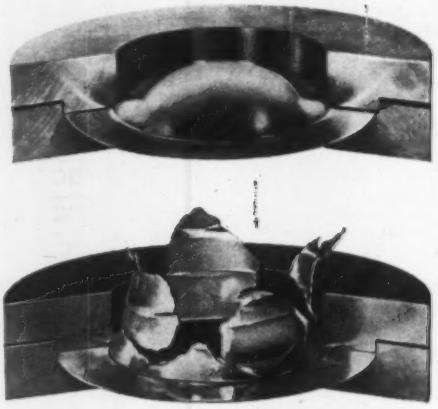

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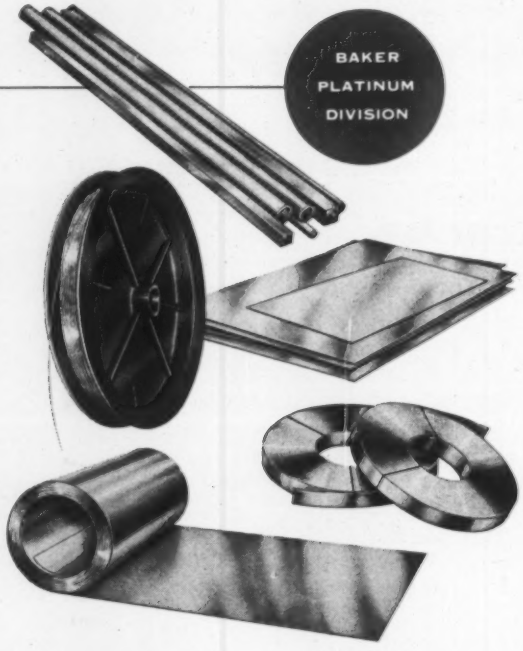

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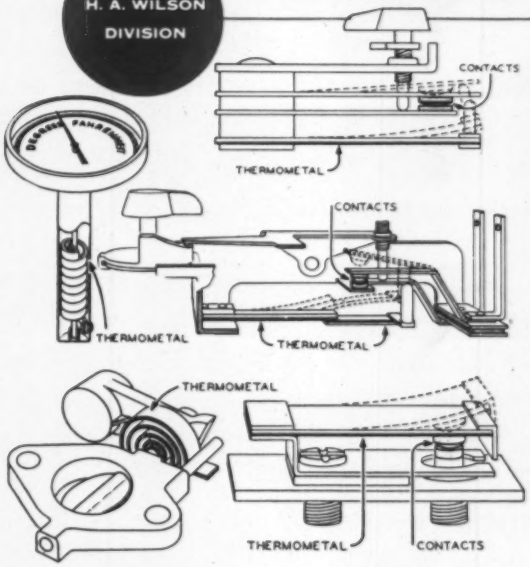

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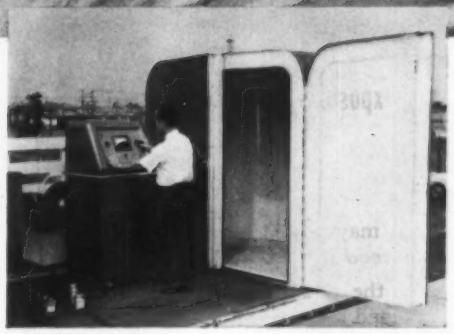

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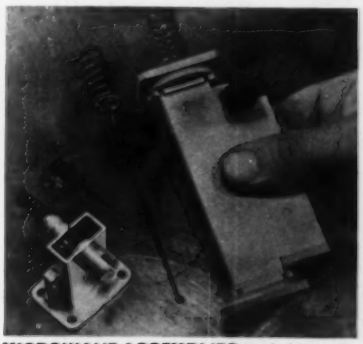

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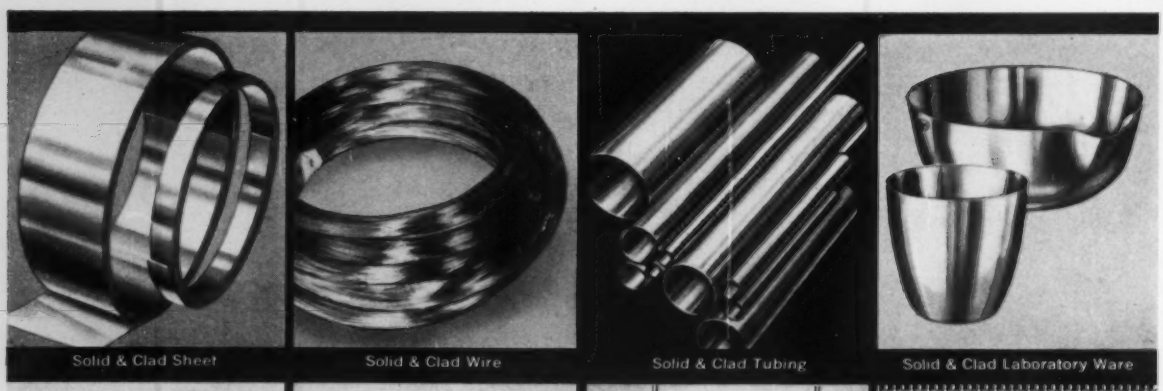

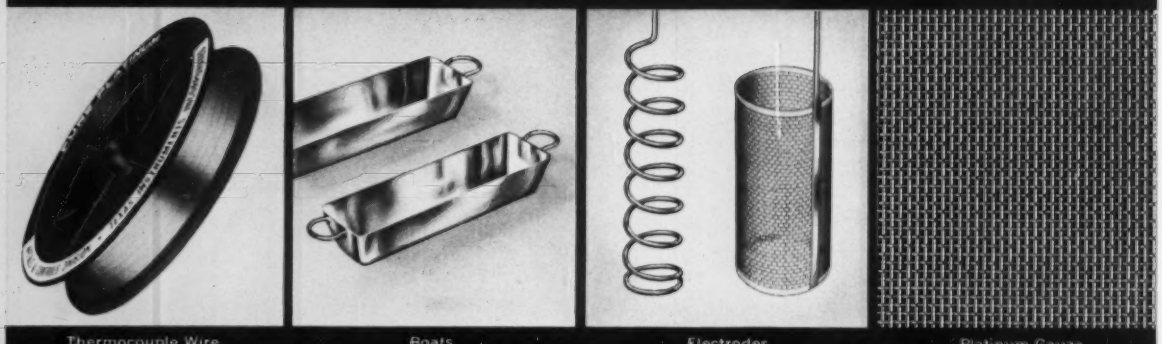

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Polyethylene clarity improved	188	620
Clear acrylic resin	202	628
OTHER NONMETALLICS		
Oriented graphite	16	608
Ceramic cylinders	194	622
Diamonds tailored for grinding, polishing	196	624
Large plywood panels	200	626
Synthetic mica paper	200	627
Wood hardboard	204	629
FINISHES, COATINGS		
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Mechanical Tubing	676
Materials for Gears	675
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Conversion Coatings for Metals	672
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Reports, p 168

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TECHNICAL LITERATURE

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Castings. Curtiss-Wright Corp., Metals Processing Div., 10 pp, illus. Facilities for research development and production of castings. 60

Welded Rings. Dresser Mfg. Div., Dresser Industries, 4 pp, illus. Tolerances and prices of flash welded ferrous and nonferrous rings. 61

Stainless Steel. Eastern Stainless Steel Corp., 4 pp, illus. Describes Type 321 SW grade of sheet and plate resulting from new method of melting ingots. 62

Permanent Mold Castings. Eaton Mfg. Co., Foundry Div., 18 pp, illus. Describes Eaton permanent mold process for producing gray iron castings. 63

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Clad Steels. Lukens Steel Co., 32 pp, illus. Mechanical and chemical properties, sizes, uses, design information and fabrication data for a series of nickel, stainless steel, Inconel and monel-clad steels. 70

Malleable Iron Castings. Malleable Founders Society, 8 pp, illus. Design considerations, machinability, and impact and corrosion resistance of standard and pearlitic malleable iron castings. 71

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Bolts, Forgings. Rhode Island Tool Co., 26 pp, illus., No. 75. Dimensions, properties, prices and uses for drop and upset forgings, eye and special bolts, studs, cap screws and nuts. 79

Metal Stampings. Rockwell-Standard Corp., Stamping Div., 8 pp, illus. Describes facilities for producing stampings and assemblies in any metal or alloy. 80

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formed sections made of galvanized, carbon, and stainless steel; brass; clad metal; copper; zinc and aluminum. 81

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Welded Honeycomb Core. Swedlow Inc., 10 pp, illus., No. N. Heat resistance, strength-weight ratios and compression strength of welded honeycomb cores made of stainless steel, titanium and Inconel X. 86

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Nonferrous Metals • Parts • Forms

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Bearing Bronze. American Smelting & Refining Co., Continuous-Cast Products Dept., 6 pp, illus., No. 301. Gives stock sizes and weights for solid and hollow continuous-cast bronze bars ½ to 9 in. in dia. 95

High Strength Aluminum Casting Alloy. Federated Metals Div., American Smelting & Refining Co., 6 pp, illus. Physical and mechanical properties, specifications, composition and foundry characteristics of a high strength aluminum casting alloy that requires no heat treatment. 96

Aluminum-Bronze Extrusions. Ampco Metal, Inc., 4 pp, illus., No. G-50. Stock sizes, weights, physical properties and specifications for extruded aluminum-bronze stock rectangles used for severe wear and abrasion applications. 97

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Aluminum Sand Castings. Ironton Aluminum Div., Dayton Malleable Iron Co., 8 pp, illus., No. 400. Facilities for producing aluminum sand castings for use in aircraft, automobiles, appliances, washing machines and outboard motors. 103

Die Castings. Dollin Corp., 16 pp, illus. Facilities for die casting large and small parts of zinc and aluminum. 104

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Castings. Eastern Malleable Iron Co., 23 pp, illus. Shows facilities for producing castings in Z metal, steel, malleable iron, aluminum, gray iron, nickel and chromium alloys. 106

Precious Metals. Engelhard Industries, Inc., D. E. Makepeace Co. Div., illus. Describes solid and laminated precious and base metals for chemical and electrical equipment. 107

Aluminum Castings. Exalco Mfg. Co., 4 pp, illus. Information on standard and custom-made aluminum permanent mold castings. 108

Tantalum Sheet, Foil. Fansteel Metallurgical Corp., Metals & Fabrication Div., 6 pp, No. 2.602-1. Ordering data, prices, sizes and tolerances for tantalum sheet and foil. 277

Aluminum Alloy. Frontier Bronze Corp., 24 pp, illus. Describes Alloy 40-E, a high strength aluminum alloy that needs no heat treatment. 109

Copper and Brass Tubing. H & H Tube & Mfg. Co. Describes a complete line of copper and brass tubing. 110

Metallic, Nonmetallic Parts. Hampden Brass & Aluminum Co., 6 pp, illus. Facilities for producing fiberglass structures, aluminum and zinc die castings, aluminum permanent mold castings, and aluminum, brass, bronze and monel sand castings. 111

Brazing Alloys. Handy & Harman, 4 pp, illus., No. 79. Advantages of silver alloys for brazing radiators, bar contacts and die inserts. 112

Titanium. Harvey Aluminum, 36 pp, illus. Thermal properties, design data, machinability, corrosion and erosion resistance, fatigue properties and uses of titanium. 113

Hydroformed Parts. Hydroforming Co. of America, Inc., 8 pp, illus., No. 559-1. Advantages and limitations of Hydroforming. Case histories show how the process has helped solve some metal shaping problems. 114

Aluminum Casting Alloy. William F. Jobbins, Inc., 8 pp, illus., No. 354. Composition, advantages, physical properties, machinability, corrosion resistance, welding data and applications of an aluminum casting alloy. 115

Aluminum Bronze Bars. Johnson Bronze Co., 4 pp, illus. Advantages of both solid and centrifugally cast, cored aluminum bronze bars. 116

Alloy Wires. Little Falls Alloys, Inc. Three folders give information on physical, chemical and electrical properties of nickel-clad titanium, bronze, brass and beryllium copper wire. 117

Phosphor Bronze. Miller Co., Rolling Mill Div., 4 pp, illus. Composition, properties, uses and availability of phosphor bronze coils and flat lengths. 118

Die Castings. Monarch Aluminum Mfg. Co., illus. Information on the mass production of aluminum permanent mold castings and aluminum and zinc die castings. 119

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Phosphor Bronze Wire, Strip. Riverside-Alloy Metal Div., H. K. Porter Co., Inc., 20 pp, illus. Composition, specifications and properties of phosphor-bronze wire, bars, rods, strip, sheets, circles and special shapes. 124

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TECHNICAL LITERATURE

Plastics & Rubber • Parts • Forms

Plastics Compounds. Allied Chemical Corp., Plastics & Coal Chemicals Div., 10 pp. Briefly outlines characteristics and applications of melamine, urea, alkyd and nylon molding compounds, and polyester and phenolic resins. **144**

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Polyurethane Foam. Dayton Rubber Co., American Latex Products Corp. Div. Uses, formulations and physical properties for rigid, semi-rigid and flexible polyurethane foams. **157**

Reinforced TFE. Dixon Corp., Plastics Div., 2 pp. Electrical, physical, mechanical and chemical properties of reinforced TFE. **158**

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Polyurethane Rubber. Dunlop Tire & Rubber Corp., Duthane Div., 4 pp, illus. Properties, uses and fabricating data for a polyurethane rubber called Duthane. **160**

Rubber, Plastics Parts. E. I. du Pont de Nemours & Co., Inc., Elastomer Chemicals Dept., 12 pp, illus., No. 85. Current issue of "Elastomers Notebook" discusses neoprene tank linings, polyurethane foam tank covers, neoprene cement and Hypalon pump linings. **161**

Custom Molded Plastics. Erie Resistor Corp., Plastics Div., 4 pp, illus. Describes facilities for custom molding plastics and shows typical products. **162**

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Polyurethane Rubber. General Tire & Rubber Co., Chemical Div., 24 pp, illus. Thermal stability, solvent resistance, adhesion and compounding of a polyurethane rubber called Denthane-S. **166**

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Phenolic, DAP Plastics. Durez Plastics Div., Hooker Chemical Corp., 16 pp, illus. Properties of 33 phenolic and 3 diallyl phthalate molding compounds. **168**

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Thermosetting Plastics Parts. Kurz-Kasch, Inc., 4 pp, illus. Parts design, materials selection, mold making and compression or transfer molding services for thermosetting plastics parts. **170**

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Custom Molded Rubber Parts. Parker-Hannifin Corp., Parker Rubber Div., 4 pp, illus., No. 5810. Describes compounding service for custom molded rubber parts. **180**

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Reinforced TFE. Rogers Corp., 10 pp. Physical and electrical properties, wear, chemical and heat resistance, and uses for reinforced TFE back-up rings, sheets, rods and tubes. **222**

PVC Sheets. Seiberling Rubber Co., Plastics Div., 4 pp. Physical, chemical, electrical and thermal properties of an unplasticized polyvinyl chloride sheet material. **187**

Acetal Resins. Shawinigan Resins Corp., 32 pp, illus. Properties and uses of polyvinyl butyral and polyvinyl formal acetal resins. **188**

Organic Chemicals, Resins. Shell Chemical Corp., Plastics & Resins Div., 8 pp. Properties and uses of organic resins, plastics, solvents and chemicals. **189**

Vulcanized Fibres. Spaulding Fibre Co., 44 pp, illus. Properties, uses and specifications of vulcanized fibres and thermosetting plastics. **190**

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SBR Rubber. Texas-U. S. Chemical Co., 23 pp. Information on light colored, oil extended and black masterbatch SBR rubbers. **194**

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Acrylic Fiber. Union Carbide Chemicals Co., Textile Fibers Dept., Div. of Union Carbide Corp., 12 pp, illus. Properties and uses of Dynel acrylic fiber. Tells how Dynel is made. **223**

Synthetic Rubber. Naugatuck Chemical Co., Div. of United States Rubber Co., 12 pp, No. 219. Compounding information, physical properties, oil and ozone resistance, and uses of a vinyl modified synthetic rubber called Paracril OZO. **196**

ABS Thermoplastic Sheet. United States Rubber Co., Royalite Plastic Products Div., 8 pp, illus., No. 59-1. Advantages, uses, and mechanical, thermal and electrical properties of ABS thermoplastic sheets. **197**

Rubber Parts. Williams-Bowman Rubber Co., 1 p. Dimensional tolerances for extruded and molded rubber gaskets, washers and rubber-covered rolls. **198**

Urethane Foams. Witco Chemical Co., Inc., 22 pp, Nos. F-1, 2 and 3. Information on polyester resins for use in the production of flexible and rigid urethane foams. **199**

Other Nonmetallics • Parts • Forms

Cemented Carbides. Allegheny Ludlum Steel Corp., 32 pp, illus. Characteristics, uses, machining data and prices of cemented carbides. **200**

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Treated Felts. Western Felt Works, Treated Felts Section. Properties and uses of felts treated with TFE, polyester and polyethylene resins. Contains samples. **220**

Finishes • Cleaning & Finishing

Corrosion Inhibitor. Allied Chemical Corp., Solvay Process Div., 17 pp. illus. Use of sodium nitrite in corrosion prevention. **225**

Chromate Conversion Coatings. Allied Research Products, Inc., 28 pp. illus. Discusses chromate conversion coatings for zinc, cadmium, copper, brass, bronze, aluminum, magnesium and silver. **226**

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Thermal Insulation. Dyna-Therm Chemical Corp., 4 pp. illus. Information on a mastic-type chemical coating designed as a high heat insulating material and an erosion and corrosion resistant coating. **229**

Rhodium Electroplates. Engelhard Industries, Inc., Baker Contact Div., 20 pp. illus. Properties and uses of rhodium electroplates. **230**

Porcelain Enameled Parts. Erie Ceramic Arts Co., 20 pp. illus. Describes porcelain enameling and discusses its use as a permanent finish for instrument dials, name plates, ashtrays, medallions and highway markers. **231**

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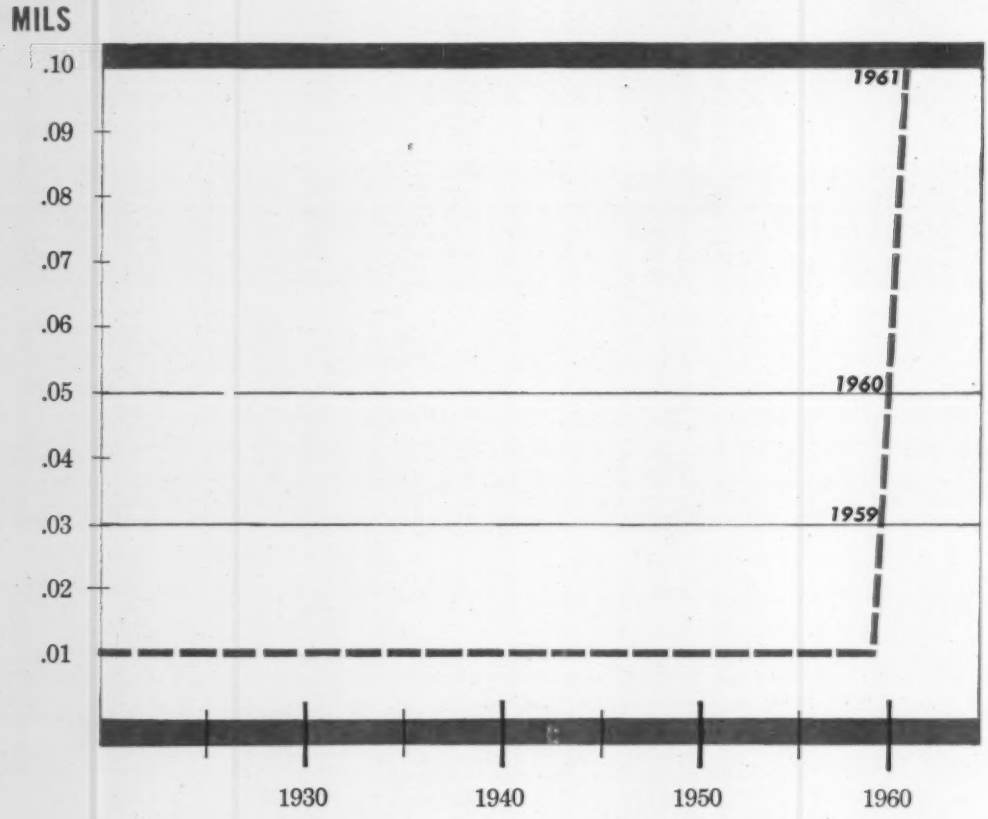

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PAGE NOS.

Adhesives 62, 72, 204
Aluminum and its alloys..60-61, 197

Beryllium and its alloys 144
Bimetals, thermostatic ...30-31, 160
Brazing 208
Brazing alloys 55, 153

Carbon, graphite ...20, 137, 174, 190
Casting alloys 2, 191, 200
Castings
Die 82, 207, 208
Ferrous 188, 200
Investment 211
Nonferrous 209
Permanent mold 70
Shell mold 70, 150
Cellular materials 8
Ceramics 152, 194
Clad metals 36
Cleaners, metal 205
Cleaning, ultrasonic 132
Coatings
Chemical conversion ..56, 136, 205
Diffusion 148
Electroless nickel 52
Flock 213
Metallic 52, 148
Organic 32, 149, 170
Copper and its alloys .....inside front cover

Diaphragms 18
Dies, custom 205
Drawn, pressed parts 198

Etching solutions 172
Extrusions
Metallic 133, 203
Nonmetallic 178

Fasteners, mechanical 50, 54, 173, 204, 210
Felts 22, 176, 211
Forgings 78-79, 145
Friction materials 53

PAGE NOS.

Gaskets 143, 213
Glass 165
Glass for reinforcement 151

High temperature materials.... 19, 29, 84, 124

Indium and its alloys..... 207
Insulation 33, 48, 67
Iron
Gray 70
Malleable 26-27

Laminates
Metal-plastics 76-77
Plastics .83, 158-159, 177, 193, 211
Lead and its alloys 48, 179
Low melting alloys 210

Metal powder parts 3, 187
Metal powders 3, 162-163
Metals (distributors) 86, 197
Molybdenum and its alloys..... 84

Nickel and its alloys 4

Packings 143, 213
Plastics
Cellulose acetate 80-81
Cellulose acetate butyrate...80-81
Cellulose propionate .....80-81, inside back cover
Epoxies 10, 49, 66
Fluorocarbons 180
Foams 8, 33, 184
Phenolics 147, 189
Polyamides (nylon) 58, 63, 73-74, 158-159
Polyester (film) 167
Polyesters 17, 158-159
Polyethylenes 63, 80-81, 140-141
Polypropylene 80-81
Polystyrene 63
Reinforced 24-25, 166, 201, 203, 206
Vinyls 7
Vulcanized fibre 158-159
Plastics moldings 199, 206
Plating processes, solutions...30-31, 44, 122, 198, 200
Platinum metals 30-31, 36
Precious metals 30-31

PAGE NOS.

Precoated & preplated metals.. 46, 183
Pressure vessels 138

Refractory materials 152
Resistance alloys 146
Rings
Metallic 164
Nonmetallic "O" 213
Roll formed parts 164
Rubber
Foam 8, 209
Moldings 133, 143, 178, 213
Silicone 213
Synthetic 151

Screw machine parts 133
Seals 133, 143, 171, 213
Sheet, hot and cold rolled..... 192
Shims 213
Silicones 119-120
Spinnings 201
Spray guns 161
Stampings, punchings 142, 202, 205, 207, 210
Steel
Heat & corrosion resistant..4, 19, 64-65, 71, 75, 157, 162-163, 185, 192
Low alloy 162-163
Specialty 21, 195
Surface patterned 68-69
Tool and die 51
Strip, precision rolled.....159, 192

Tantalum and its alloys..... 84
Temperature indicators 196
Testing equipment 182, 186
Testing service 156
Titanium and its alloys.....162-163
Tubing & pipe, metallic..57, 139, 155, 175, outside back cover

Vacuum melted alloys....28, 162-163

Weldments 198
Wire 34-35, 59, 135, 203
Wire forms 154, 202

Zinc and its alloys..... 2
Zirconium and its alloys..... 47

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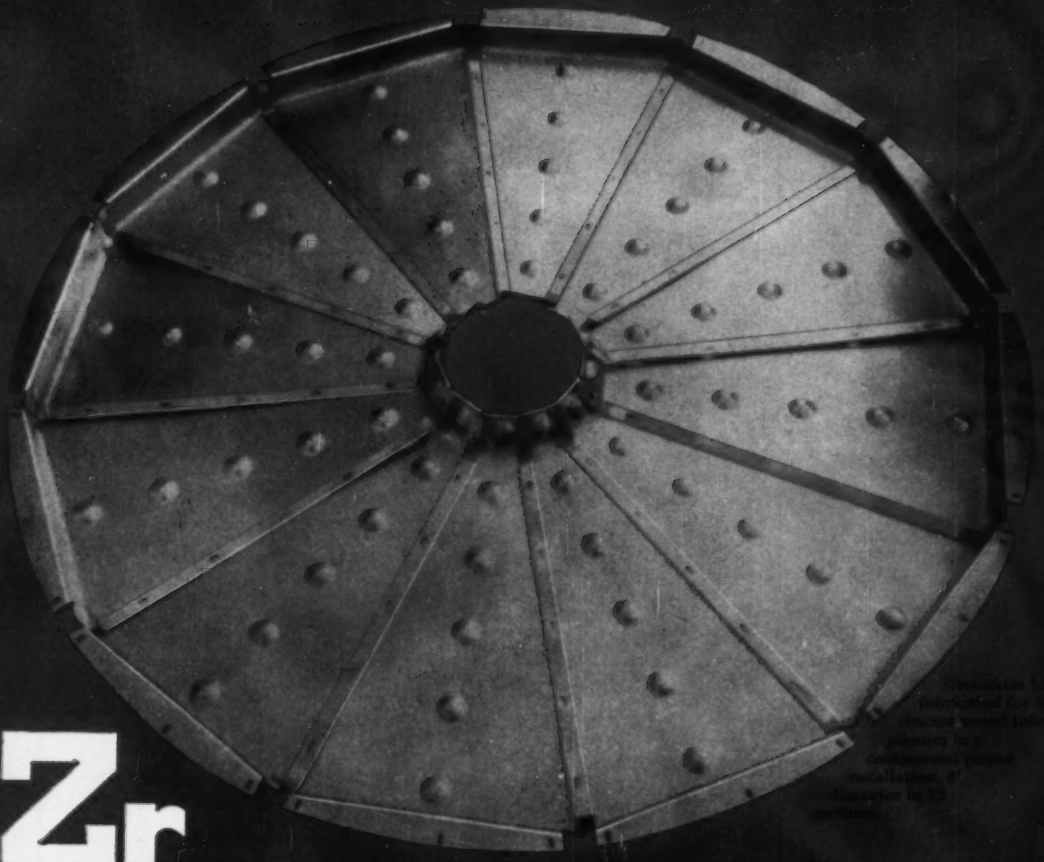

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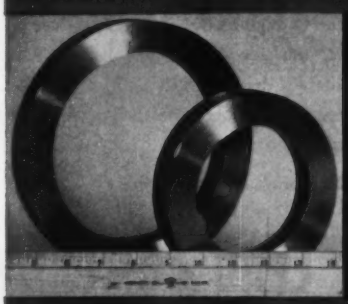

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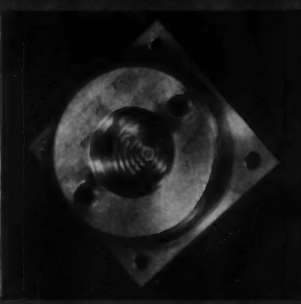

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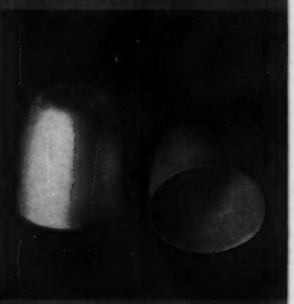

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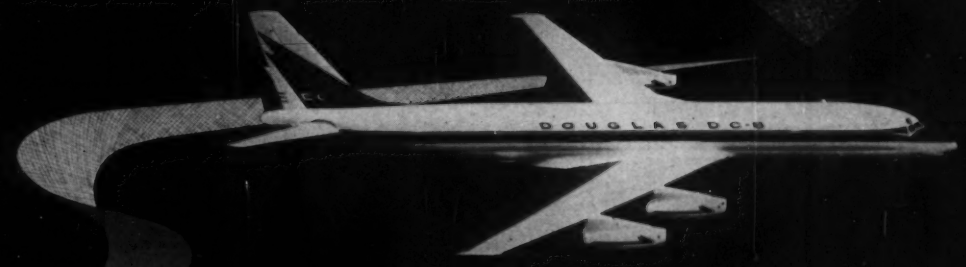

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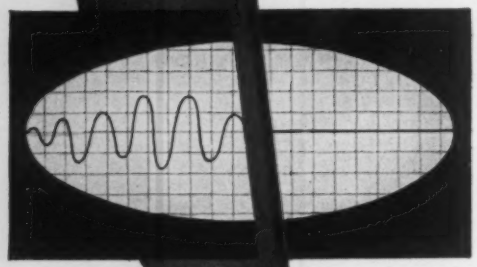

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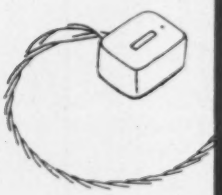
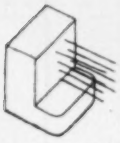
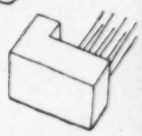
A Major Breakthrough in Plastic Molding



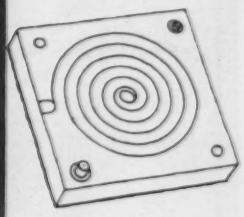


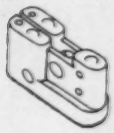


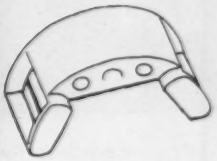
EMC

EPOXY

MOLDING COMPOUNDS







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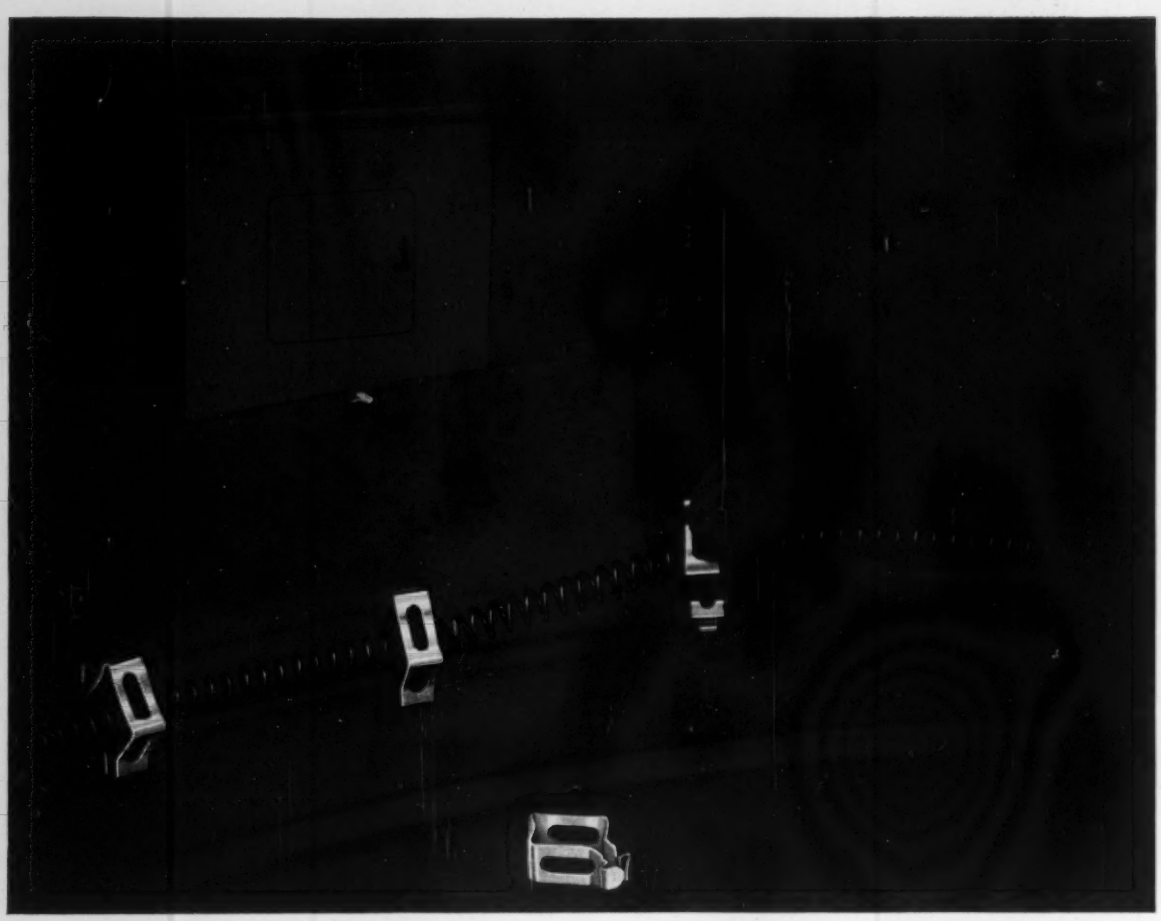

Engineered by Tinnerman . . .

SPEED CLIPS® reduce costs, simplify assembly and servicing on Maytag "Halo of Heat" Dryer

Clothes are dried efficiently in the famous Maytag "Halo of Heat" automatic dryer. And now the quality of the "Halo of Heat" dryer is even better than ever because its unique circular heating element is fastened quickly, securely by 22 special Tinnerman SPEED CLIPS developed by joint efforts of Tinnerman and Maytag designers.

Each one-piece SPEED CLIP eliminates a separate welding operation on the "Halo of Heat" assembly. Various screw-driving operations formerly required on Maytag's assembly line to capture the ceramic insulator and secure the mounting clamp were also eliminated, with equally interesting reductions in cost. Now, the stainless steel, vibration-proof fastener is snapped in place with simple "button-hook" action. No special skills or equipment are required. Assembly and parts costs have been reduced . . . *substantially!* Serviceability in the field has been improved.

A free Tinnerman Fastening Analysis of your own product can show you where similar assembly and cost-saving advantages are possible. Call your Tinnerman representative—he's listed in the Yellow Pages under "Fasteners". Or write to:

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Speed Nuts®

FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano-Bundy GmbH, Heidelberg.

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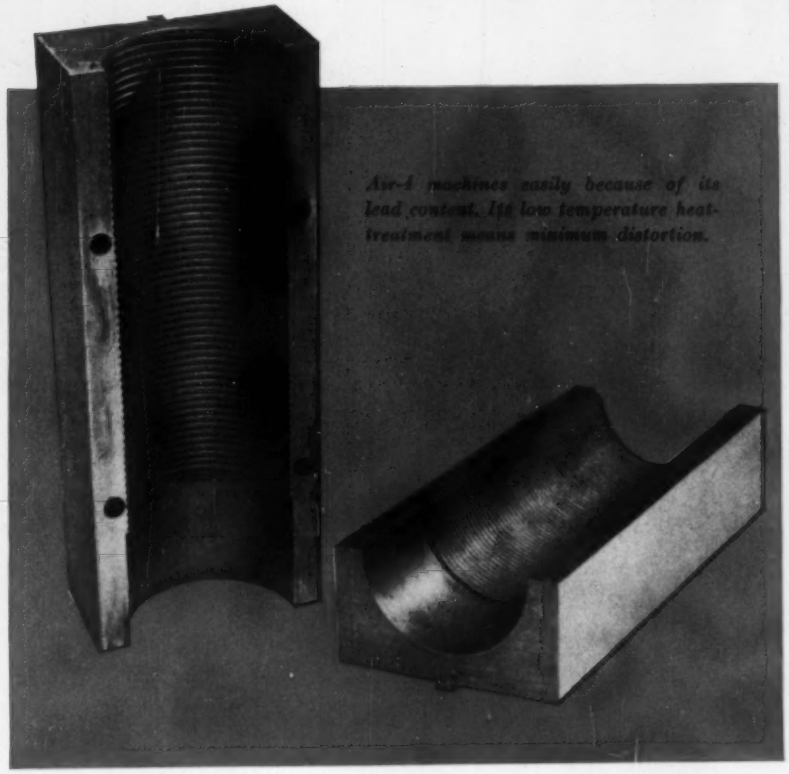
Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.



Another Report on AIR-4 TOOL STEEL:

"These clamping bars machined like a dream, and distortion was kept to a minimum."

The clamping bars above, of Bethlehem Air-4 tool steel, were made by Miller Tool and Die Company, Gloucester, N.J. John J. Nesbitt, Inc., Philadelphia, uses them for holding and expanding metal tubing. The dies, hardened to Rockwell C 57-58, were each machined from a piece of Air-4 1¾ in. thick, 3½ in. wide, and about 8 in. long. The over-all tolerances were plus or minus .002 in.

Easy to Machine, Low Distortion

According to our local tool steel distributor, Horace T. Potts Company, the customer reported that the machinability was "like a dream." And they were also delighted with the lack of distortion during heat-treatment—"best distortion-resisting grade we've ever used for this type of die."

Hardens in Air at 1550F

Air-4 is our new free-machining medium-alloy tool steel. It hardens in air at low temperature—about 1550F. It has excellent free-machining characteristics because of its addition of lead. Air-4 also has superior wear-resistance, high toughness, and deep-hardening properties, making it ideal for long tool life.

If you would like to have additional information about Air-4, get in touch with your Bethlehem tool steel distributor. Better still, order a trial bar and put it to work in your shop.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

The Direction of Grinding Marks Affects the Life of Tools

It might be well to take a good look at your tool-grinding practice, because it has been proved time and again that the direction of grinding marks has a direct bearing upon tool life. This is especially true with such tools as deep-drawing dies, and punches that have a moving contact with metals under high pressures.

No matter how fine or smooth the surface finish of ground tools may appear to be, don't be fooled—it actually has a saw-tooth contour. Material which moves parallel to the grinding marks shows much less tendency to "pick up," or adhere, than material moving across the grinding marks. But this "pick up" of material can't be permitted on such tools as drawing dies, where it's advantageous to grind in the same direction as the material moves. On some types of tools this kind of grinding is difficult, but the longer tool life justifies the effort. Punches which are ground longitudinally last much longer than those ground circumferentially, the most common method. Here also, longitudinal grinding is inconvenient, but worthwhile.

Although the direction of grinding on tools isn't given much thought in the average shop, it is often a big factor in getting the best possible tool life.

Send for TOOL STEEL LITERATURE

If you would like to receive booklets on Bethlehem tool steels, indicate your choice on this coupon, and mail to Room 1043, Publications Department, Bethlehem Steel Company, Bethlehem, Pa.

- ☐ Hot Work
- ☐ High Speed
- ☐ Carbon and Carbon-Vanadium
- ☐ Shock Resisting
- ☐ Hollow Bar
- ☐ Oil and Air Hardening
- ☐ Special Purpose
- ☐ Lehigh H (High Carbon, High Chrome)
- ☐ Bearcat
- ☐ Tool Steel Selector

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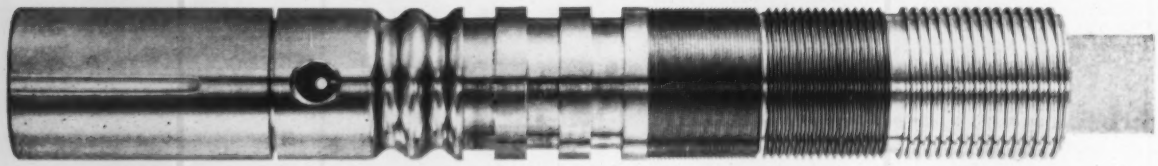
THEY LAUGHED WHEN WE SAT DOWN TO PLATE...

they didn't know about KANIGEN®



This shaft was turned. It was key-slotted, drilled, tapped and shouldered. It was threaded, milled, grooved and chamfered. It was step-bored, with three inside diameters. Who could plate a piece like this all over—inside and out—and expect a uniform coating?

Well, anyone who used KANIGEN® could expect it—and get it. In fact, we made this piece especially to prove it.

The KANIGEN® process for chemical nickel alloy plating produces a uniform thickness of coating, regardless of the contours of a part. This uniformity permits full machining operations prior to coating, with no subsequent cleanup.

KANIGEN® offers corrosion resistance equal or superior to that provided by wrought or electrolytic nickel.

For complete technical details write or call your nearest General American office. Ask for Kanigen Bulletin No. 258. You'll find that with plating as in so many other industrial areas, *it pays to plan with General American.*

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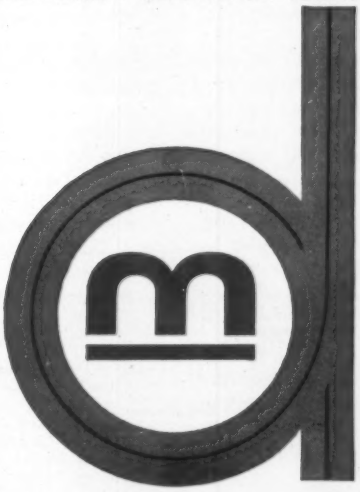

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R B & W FASTENER BRIEFS

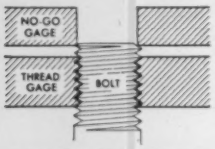
MAKING THE MOST OF MODERN MECHANICAL FASTENING

Technical-ities

By Fred E. Graves

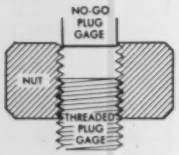
Proper inspection for screw threads

Thread inspection should answer two questions. (1) Will the threads allow easy *assembly?* (2) Is there sufficient thread depth for strength?



EXTERNAL THREADS

Strength requires sufficient thread flank engagement, which is checked by a *minimum* major diameter *plain* ring "no go" gage. Assembly is controlled by thread lead and maximum metal, which are checked by a *threaded* ring "go" gage.

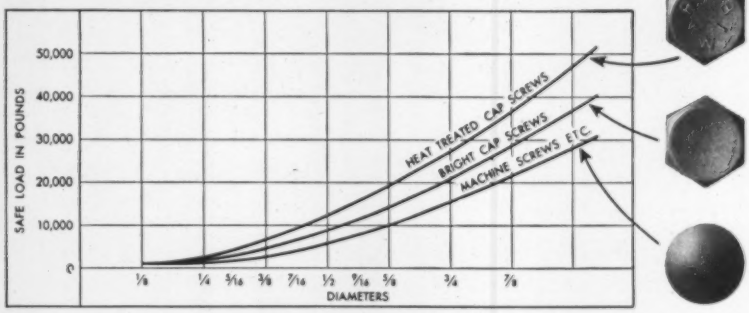


INTERNAL THREADS

The same reasoning holds true here. Use a threaded plug "go" gage to determine any interferences from thread lead or thread diameter that hinder ease of assembly. The unthreaded "no go" plug will assure proper thread depth for sufficient flank engagement.

Checking both thread lead and pitch diameter with two threaded "go" and "no go" gages not only increases inspection cost but also permits acceptance of pieces with insufficient thread metal.

How to simplify selection of fastener material



Safe loads for fasteners made from the three most common steel grades are shown on these curves. Curve for Grade 2 is smooth through the ⅞" size. There is no drop in proof load because RB&W fasteners up to 6" long are cold headed even in 1" diameters.

Basic job of a mechanical fastener is *physical.* It's designed to exert a clamping force.

Fasteners from a *standard* analysis of steel satisfy a majority of the usual requirements for this function. Most times, then, specifications should concern themselves solely with *physicals* for the job. Asking for certain chemical analyses to get the right physicals is doing it the hard way. It can create a needless cost penalty besides.

WIDE RANGE OF LOADS

Generally, the desired physicals can be delivered by a combination of cold working and heat treatment of one of the following common grades.

Grade 1 (or SAE 1010) steel goes into fasteners that offer a design load of 30,000 psi, such as carriage bolts and machine screws.

Grade 2 (or SAE 1018, 1020, 1021) steel goes into bright hex screws and similar items with a recommended design load of 40,000 psi in sizes up to ¾". SAE proof load then drops from 17,350 lbs. in ¾" size to 12,900 lbs. in ⅞" size *unless cold heading is specified!* This is because larger fasteners are often hot headed, resulting in some annealing. The strengthening effect of cold working is lost.

Grade 5 (SAE 1038) steel provides high strength heat treated bolts and hex screws with 60,000 to 80,000 psi design load range.

USE THE FULL INHERENT STRENGTH

When calculated load on a fastener is below those values, you're wasting its strength and cost. Using the smallest size fastener consistent with the load, and tightening to its maximum load actually increases joint strength.

When you need an alloy steel because of space or weight or higher temperature or strength requirements, specifying physicals will automatically force your supplier to go to high alloy steel.

You will get what you need without selecting the exact alloy to be used. Just be sure you're served by a technically qualified and experienced fastener manufacturer.

Bulletin DC-2 gives other helpful hints. Send for it—or the RB&W Man. Russell, Burdsall, & Ward Bolt and Nut Company, Port Chester, New York.

Plants at: Port Chester, N.Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

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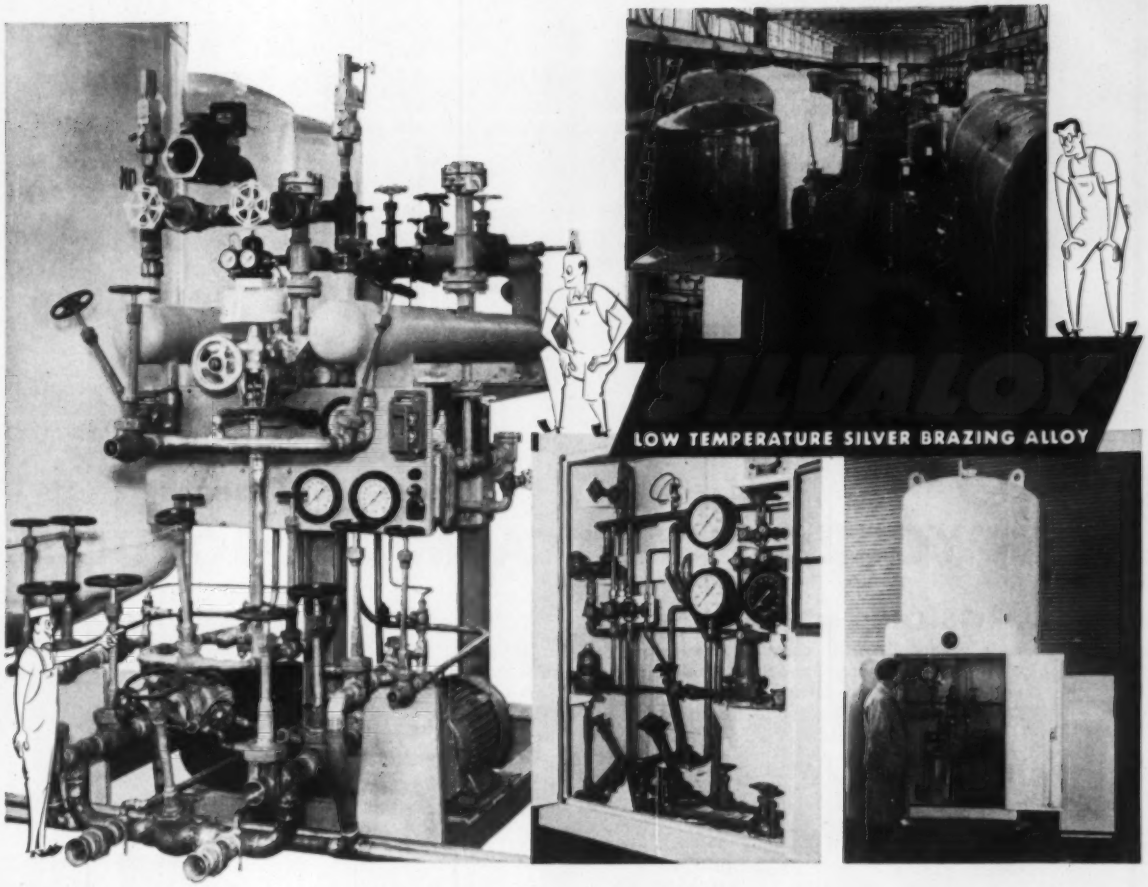

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The liquefied gas storage vessels manufactured by Ryan Industries, Inc., foremost manufacturer in this field, are subject to pressures to 500 p.s.i. — temperatures to minus 320°F. and vacuum less than 10 microns absolute pressure. The joints in the "plumbing and valving" of these vessels *must* safely withstand the extremes in temperature and pressures encountered in the storage and transfer of liquefied gases.

Ryan Industries depends upon Silvaloy Brazing Alloys and Fluxes to provide the necessary extra strength and leakproof characteristics required in joining valves, regulators, filters, thermometers, gauges, level indicators and fittings in the control cabinet. The quality of Ryan products is *insured* — with Silvaloy joints—*as strong as or stronger than the parent metals.* Silvaloy Brazing Alloys and Fluxes are helping to speed production, lower costs and improve results in many fields. Call your nearest Silvaloy Distributor for information or assistance.

RYAN INDUSTRIES, INC.

of Cleveland, Ohio, manufacture liquefied gas storage vessels ranging in capacity from 3000 to 1,500,000 standard cubic feet.

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Two complete reference manuals for low-temperature silver brazing and fluxing are available upon request. Send for either one or both.

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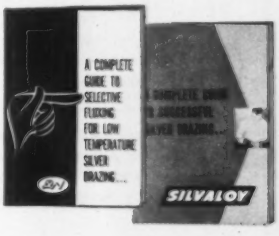

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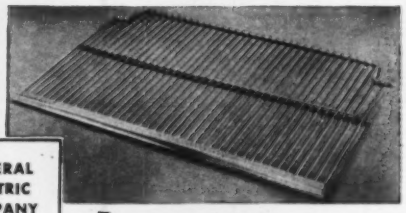
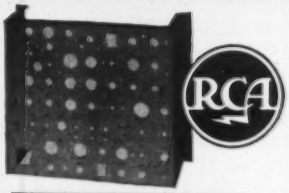
Iridite, in combination with other Allied Research processes, can provide a wide variety of finishes. As an example, Iridite 8-P applied to zinc or cadmium, followed by an application of Irilac, gives a highly attractive simulated brass finish.



GENERAL ELECTRIC COMPANY



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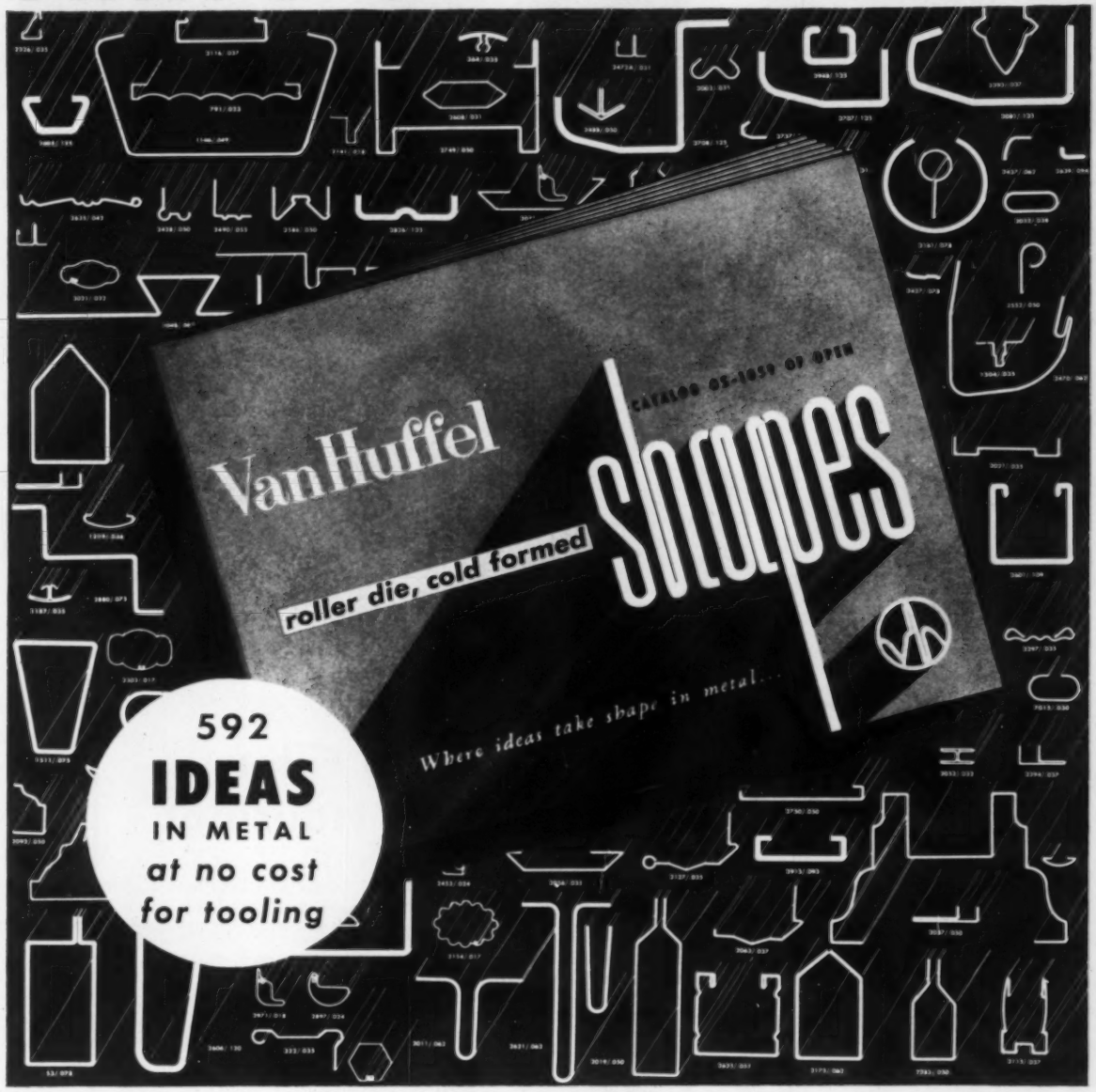
BOOK SHAPE OF THE MONTH



Illustrated, greatly reduced, are a few ideas that have taken shape in metal.

MAIL THE COUPON FOR FREE OPEN SHAPE CATALOG

48 page catalog OS-1059 illustrates (actual size) over 500 roller die, cold formed metal shapes for which rolls and dies are on hand thus eliminating tooling costs to the purchaser of any of the shapes illustrated.

Van Huffel Tube Corporation, Warren, Ohio

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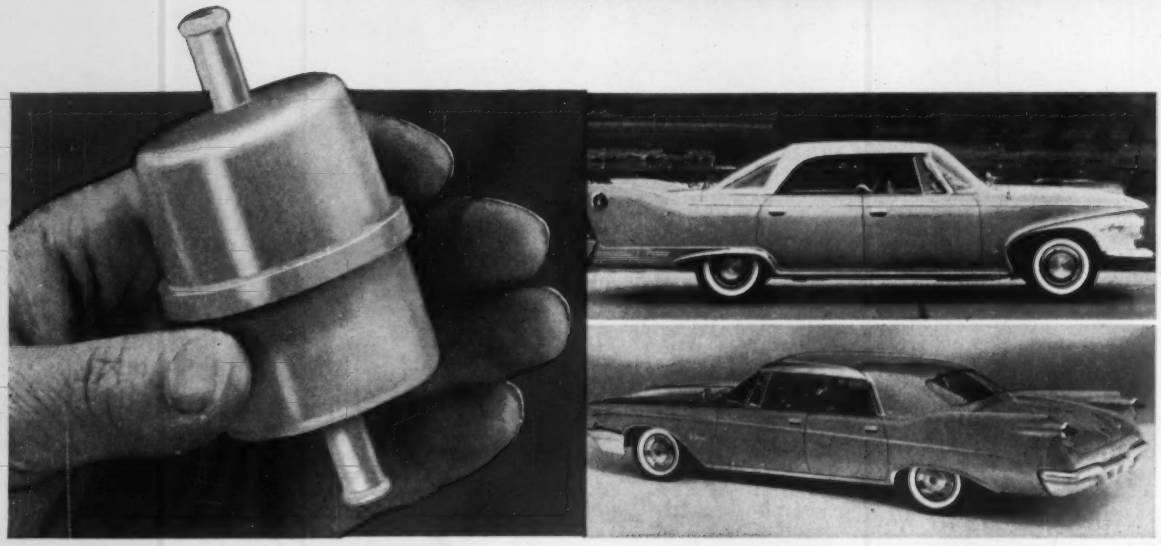
New ideas in NYLON



This new MōPar fuel filter featuring a molded Spencer Nylon housing is now installed in 8-cylinder Chrysler Corporation automobiles for 1960. Shown above are the 1960 Plymouth and Imperial.

New Advance in Precision Automotive Parts . . .

Chrysler Introduces New Fuel Filter With Molded Spencer Nylon Housing:

Marking another major advance in precision automotive parts, Chrysler Corporation is now installing a new MōPar fuel filter with a molded Spencer Nylon 404 housing in its 8-cylinder automobiles for 1960. The filter is currently being supplied to Chrysler by the Fram Corp.

Representing one of the toughest automotive uses yet assigned to a plastic, the new MōPar fuel filter was subjected to several torturous tests before it was accepted by Chrysler Corporation. Tests like these:

For more than 1,000 hours, the fuel filter quivered on a special machine to gauge its ability to withstand vibrations over the entire frequency spectrum.

To test the heat-cold resistance of the new filter, it was "baked" for 24 hours at 250° F. Then it was "frozen" at —40° F. for an additional 24 hours.

Oil heated to 140° F. was poured through the filter's Spencer Nylon housing to determine its resistance to greases.

And there were other excruciating tests. But throughout them all, the Spencer Nylon housing proved to have excellent heat stability, impact strength and resistance to hydrocarbons and corrosion. Spencer Nylon has also shown superior moldability and sealability.

As a leader in the development of nylon for automobiles, jet airliners and other products, Spencer Chemical Company has the experience and personnel that can help you put nylon to work in your products.

For more information about the properties of Spencer Nylon and how they may help you solve a materials problem, contact Spencer Chemical Co., Dwight Bldg., Kansas City 5, Missouri.

SPENCER® SPENCER CHEMICAL COMPANY

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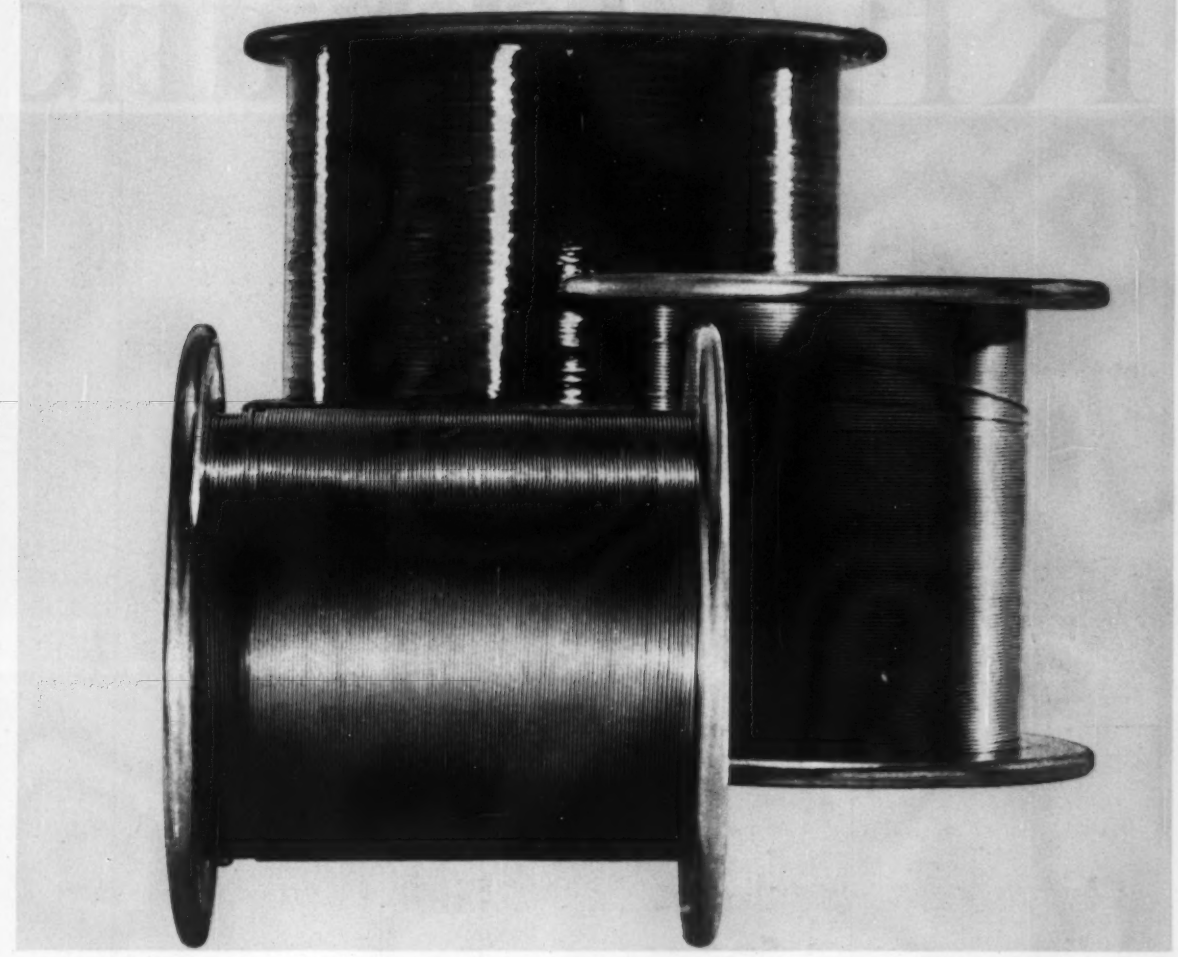
SYLVANIA MAKES ALL THREE—ALLOY, CLAD AND PLATED WIRE



How to speed up design of new products

—call Sylvania for an unprejudiced recommendation on wire

With design time for high-temperature equipment so much at a premium, it pays *not* to get bogged down by noncreative engineering details. Case in point: selecting wire to meet specific conductivity needs in corrosive or oxidizing atmospheres.

You can save valuable time by calling on Sylvania for a wire recommendation. You see, Sylvania knows wire—knows the particular advantages of each kind. And of all major manufacturers, only Sylvania makes all three types of bare wire—alloy, clad and plated. Available in a complete range of sizes—.002 to .250, retains optimum characteristics at temperatures up to 1600° F.

Result? Your Sylvania wire recommendation is unbiased. It's based on *your* design's needs and is not restricted by a limited line. You can get full details for future use—or timesaving help on your present project—by writing Sylvania Electric Products Inc., Parts Division, Warren, Pennsylvania.

SYLVANIA

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

GENERAL TELEPHONE SYSTEM

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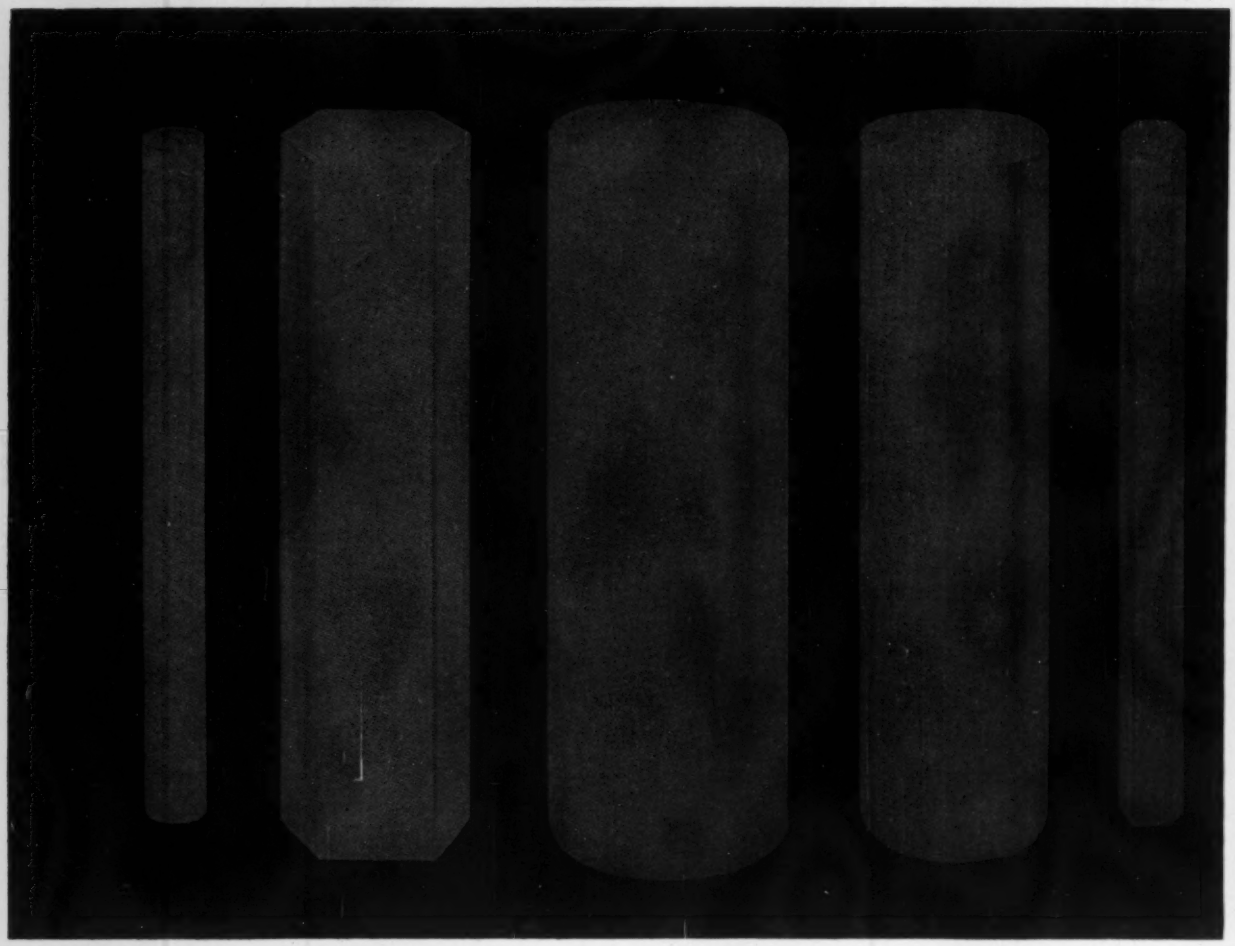
READY and



Bridgeport–a new prime

HOW NEAR IS YOUR PHONE? Bridgeport's new and expanded warehouse service on aluminum, brass and copper is just that close!

Of course, the added convenience of fastest delivery is only *one* of the advantages Bridgeport offers. You can also count on "all-the-way-through" quality that's the result of exacting care in alloying, tempering, finishing and testing. Careful adherence to tolerances, too. In fact, when you dial your Bridgeport warehouse, you're dialing *a tradition*—of service, of quality!

What's more, these same warehouse facilities are the perfect service source for special aluminum shapes, extrusions. Copper and brass alloys, too. Start *today* to get prime products, prime service—from Bridgeport!

Bridgeport Aluminum Screw Machine Rod

Alloys:	2011-T3 2017-T4 2024-T4 6061-T6
Diameters:	½" to 2" Rounds or Hexagonals
Lengths:	12-foot standards

waiting!

source for ALUMINUM

Bridgeport Aluminum Coiled Sheet

Alloys: 1100 3003 3004 5005 5050 5052 5357

Widths: Up to 24" • Gauges: .006 to .064

Tempers: All commercial. Slitting service available.

Check these Bridgeport warehouses and offices for fast, local service

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CLEVELAND: CEdar 1-5180
DENVER: MAin 3-0273, AComa 2-4108
ST. LOUIS: CEntral 1-0076
LOS ANGELES: RAymond 3-5101, PArkview 1-5171
MINNEAPOLIS: FEderal 9-7061
NEWARK (Hillside): Bigelow 3-0044
SAN FRANCISCO: UNderhill 1-2551
NEW YORK: EXeter 2-4290
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BRIDGEPORT BRASS COMPANY

Bridgeport 2, Connecticut • Sales Offices in Principal Cities

Specialists in Metals from **A***luminum to* **Z***irconium*

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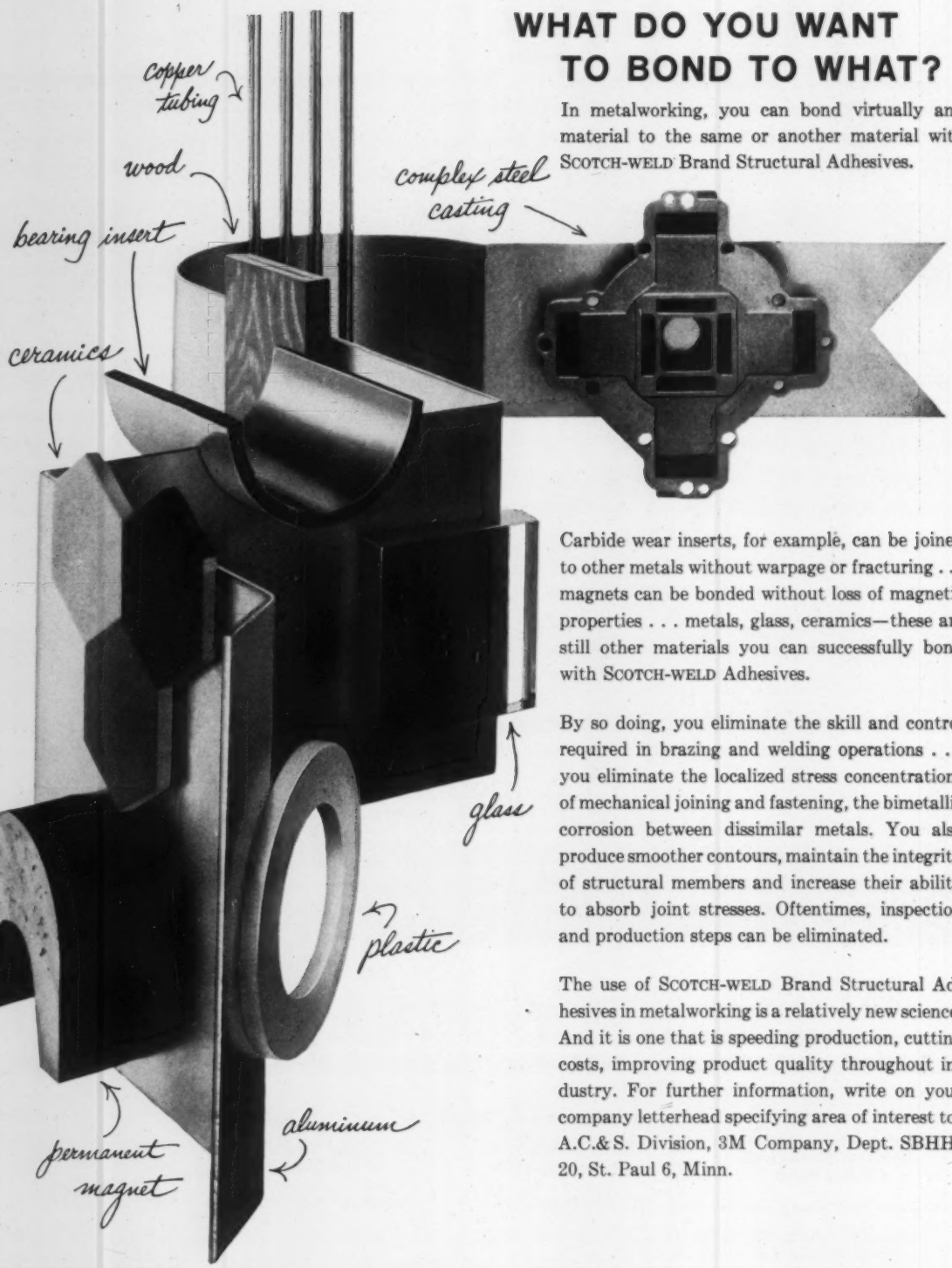
WHAT DO YOU WANT TO BOND TO WHAT?

In metalworking, you can bond virtually any material to the same or another material with SCOTCH-WELD Brand Structural Adhesives.



Carbide wear inserts, for example, can be joined to other metals without warpage or fracturing . . . magnets can be bonded without loss of magnetic properties . . . metals, glass, ceramics—these are still other materials you can successfully bond with SCOTCH-WELD Adhesives.

By so doing, you eliminate the skill and control required in brazing and welding operations . . . you eliminate the localized stress concentrations of mechanical joining and fastening, the bimetallic corrosion between dissimilar metals. You also produce smoother contours, maintain the integrity of structural members and increase their ability to absorb joint stresses. Oftentimes, inspection and production steps can be eliminated.

The use of SCOTCH-WELD Brand Structural Adhesives in metalworking is a relatively new science. And it is one that is speeding production, cutting costs, improving product quality throughout industry. For further information, write on your company letterhead specifying area of interest to: A.C.&S. Division, 3M Company, Dept. SBHH-20, St. Paul 6, Minn.

ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

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The big difference in Foster Grant resin . . .

40 YEARS of Successful Plastics Experience

Foster Grant is *one* leading plastics producer that has never lost the ability to understand molders' problems. This is because Foster Grant entered the plastics business in 1919 both as a raw material customer and as a manufacturer of end products.

Through the years, Foster Grant has been successful at merchandising, mold design and machine building. In fact, in 1931, it was Foster Grant who introduced the first successful injection molding machine to America.

In the plastics industry, Foster Grant alone offers a quality line of resins "production tested" in its own molding facilities—many of them pioneered by its own engineers.

The value of this lifetime of successful, first-hand plastics experience is yours to draw on when you mold with Foster Grant resins.

Your Partner in Plastics Progress **FOSTER GRANT**

LEOMINSTER, MASS.

Sales Offices: Chicago Detroit • New York and strategically located warehouses

Plants: Leominster, Mass. Baton Rouge, La. Manchester, N. H.

Also distributed by: H. Muehlstein & Co., Inc. 60 East 42nd Street, New York 17, N. Y.

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Manufacturers of Fostarene® Polystyrene • Fosta® Nylon • Fosta Tuf-Flex® Impact Polystyrene

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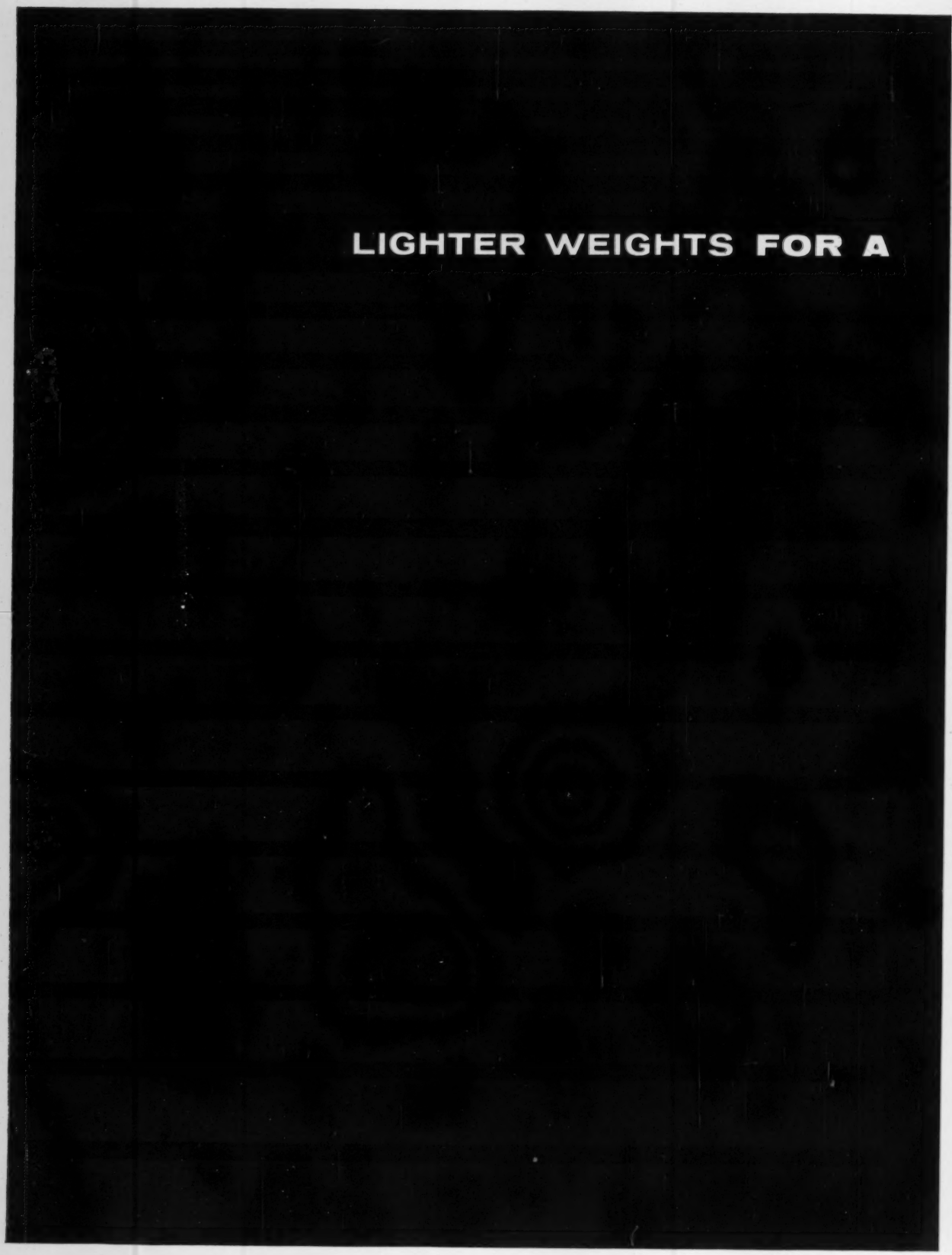
LIGHTER WEIGHTS FOR A

HEAVIER PROFIT

Order a ton of stainless steel sheets and you receive a ton of stainless steel. But the square footage of that steel can differ.

Eastern's precision rolling holds the gauge toward the light side of recognized tolerances . . . actually delivers more area of stainless per ton. Result: Since you sell by the square foot, you earn more dollars per sale.

There's profit in precision rolled stainless from Eastern.

EASTERN

STAINLESS STEEL

BALTIMORE 3, MARYLAND, U. S. A.

stainless steel sheets, plates, strip, coils

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HYSOL

OFFERS
A COMPLETE
LINE OF
SUPERIOR QUALITY
EPOXIES . . .

ADHESIVES & SEALANTS
ELECTRICAL INSULATING
COMPOUNDS FOR . . .
CASTING
ENCAPSULATING
IMBEDDING
IMPREGNATING
MOLDING MATERIALS
TOOLING MATERIALS
EPOXI-PATCH KITS
CAST ROD, SHEET & TUBE
CUSTOM FORMULATIONS
AND PACKAGING

HYSOL CORPORATION
formerly Houghton Laboratories, Inc.

Nothing has changed but the name . . .

Acceptance of our brand name HYSOL has been so universal that we are changing our name from Houghton Laboratories, Inc. to HYSOL Corporation.

As America's first manufacturer of the highest quality epoxy resin electrical insulating materials, adhesives, tooling materials and cast products, we believe HYSOL Corporation more accurately reflects the full scope of our products and services.

Nothing is changed but the name. Our company policy remains unchanged. We renew our pledge to a continuing program of research, responsibility and results which can only mean progress in the field of epoxy compounds.

HYSOL CORPORATION
OLEAN, NEW YORK
Progressive Products thru Chemical Research

HYSOL OF CALIFORNIA
LOS ANGELES, CALIF.

HYSOL (CANADA) LTD.
TORONTO, ONTARIO

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Insulate to 2000°F. with REFRASIL

This may be the SPECIAL INSULATION you're looking for!

REFRASIL PHYSICAL PROPERTIES:

- Chemical resistance of pure silica
- Resists temperatures up to 3000° F. under certain conditions
- Low Thermal conductivity
- Fiber diameter .00020-.00040 in.
- Specific heat .19 (Batt)
- Thickness .14-.15 in. (Batt)
- Surface density .05 lb./sq. ft. (Batt)

REFRASIL USES:

- 2000° F. continuous high temp. insulation
- Filtration of corrosive materials
- Removable, insulating blankets
- REFRASIL Reinforced Plastics (ASTROLITE for up to 15,000° for short duration)
- Thermocouple wire insulation
- Electric muffle furnaces
- Laboratory heating mantles

If you're looking for an efficient, lightweight 2000°-3000°F. insulating material in any of the physical forms shown above, REFRASIL may be your best answer.

Long proven for jet aircraft and missile use, REFRASIL is fast becoming an important industrial insulation for −300°F. cold to +3000°F. heat.

When other insulation materials fail in critical high temperature use, write or call for test samples of REFRASIL. It may be the *special* insulation you're looking for!

• *Write for REFRASIL Product Bulletin and Price List.*

HITCO

H. I. THOMPSON FIBER GLASS CO.

1733 Cordova Street, Los Angeles 7, Calif. • REpublic 3-9161

WRITE OR CALL YOUR NEAREST HITCO REPRESENTATIVE: EASTERN: Tom Kimberly, 38 Crescent Circle, Cheshire, Conn., BR. 2-6544; Fred W. Muhlenfeld, 6659 Loch Hill Rd., Baltimore 12, Md., VA. 5-3135 • **MIDWEST:** Burnie Weddle, 3219 W. 29th St., Indianapolis 22, Ind., WA. 5-8685 • **SOUTHWEST:** Marshall Morris, 2850A W. Berry, Rm. 7, Fort Worth, Tex., WA. 4-8679 **NORTHWEST:** J. L. Larsen, 5757 Oaklawn Pl., Seattle, Wash., PA. 5-9311 • **CANADIAN PLANT:** THE H. I. THOMPSON CO. OF CANADA LTD., 60 Johnston St., Guelph, Ont., TA. 2-6630

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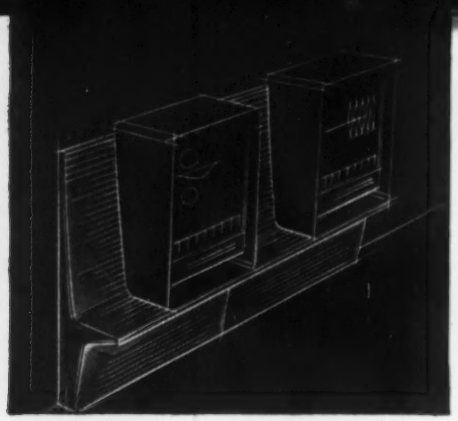


SHARONART*

a new idea in steel . . . sparks a new idea in

Famed designer Peter Schladermundt creates new machine concept using New Sharon Steel.

Vending machines can now stay brighter, newer, longer . . . thanks to amazing new Sharonart*.

Believing few machines are subject to the abuse received daily by the vending machine, nationally famous designer Peter Schladermundt recognized the many advantages Sharonart* would impart to this hard working equipment.

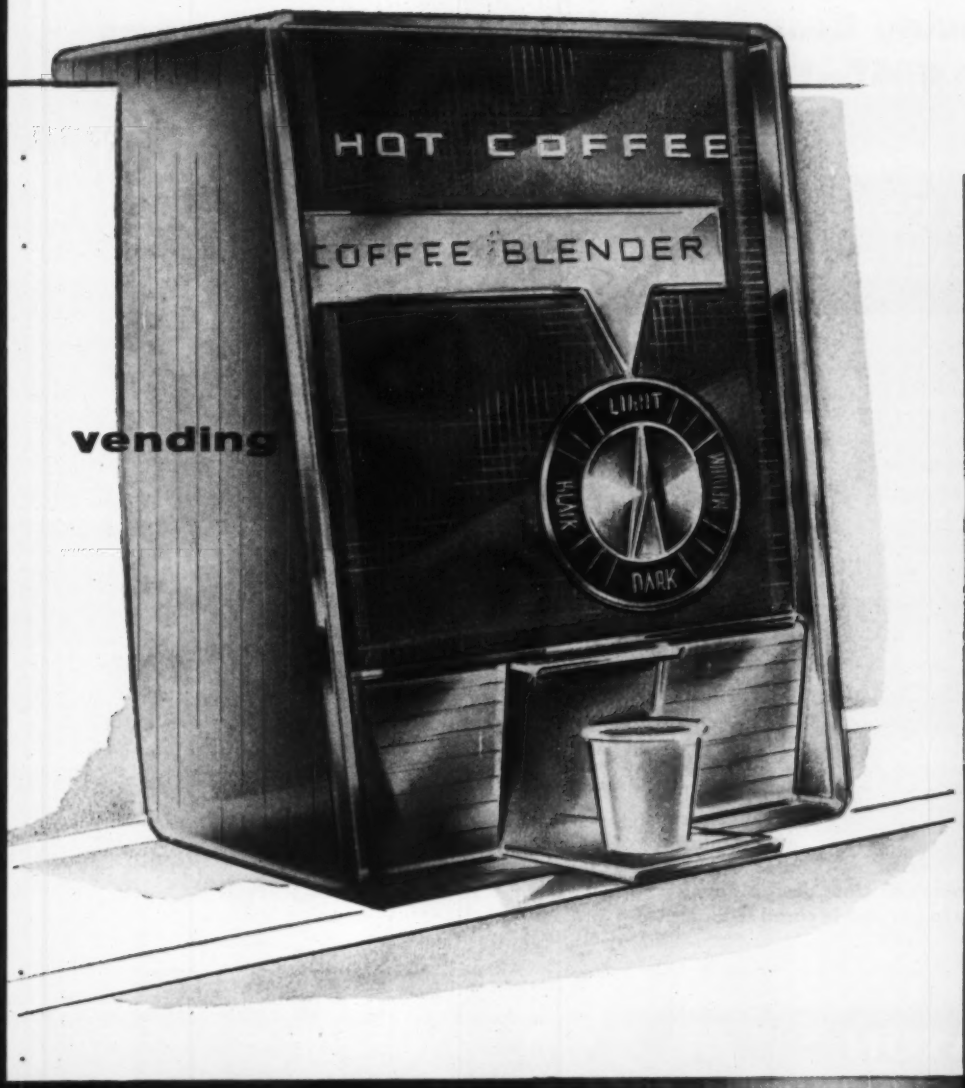
Sharonart* is patterned steel at its finest . . . and the many pattern combinations present a new plateau for the machine designer. He can now make model changes simply by altering steel patterns. But more important, Sharonart* resists marking and now vending machines will be able to absorb much more punishment without losing their attractiveness. Too, with modern painting techniques, manufacturers are able to achieve smart, new color combinations to give their product even greater beauty and sales appeal.

Wherever functional beauty and long life are desired, Sharonart* is the one perfect metal. For additional information write Sharonart, *Sharon Steel Corporation, Sharon, Pa.*

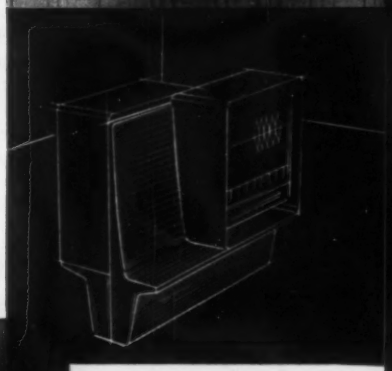
Aside from designing the vending machine of Sharonart, Peter Schladermundt has created an entire new process of machine vending. By developing special racks, machines can be easily added and removed according to demand, and/or for refilling. Rack could be made as a fixed wall type, or as an island, with machines operated from both sides. Machines could be hung individually or doubly, saddle style.*

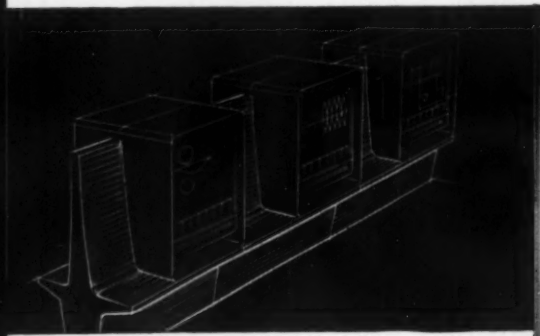
Note: The vending machine idea illustrated on these pages is not now a manufactured product. It is a design only. *TM

SHARON *Quality* **STEEL**



vending





SHARONSTEEL

For more information, circle No. 453

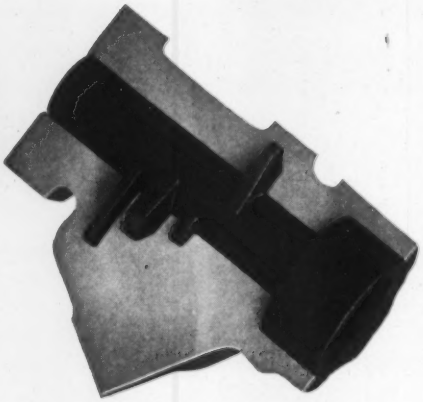
Can You Use BETTER Gray Iron Castings?

Eaton's Continuing Research and Development Programs Assure You the BEST—Engineered to Your Individual Needs

EATON PERMANENT MOLDING

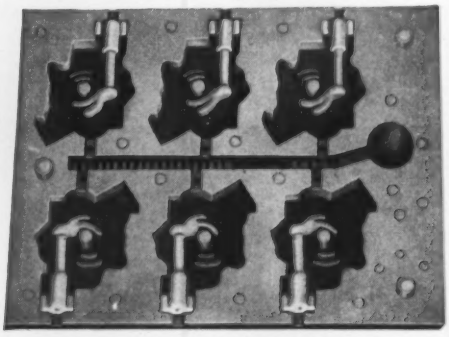
Because of the denser, non-porous, homogeneous structure, Eaton Permanent Mold Castings meet critical quality requirements. The finer dispersion of graphite provides a better material where free machinability and accuracy are essential in critical machining operations. Eaton annealed gray iron castings are available in sizes from one tenth of a pound to fifty pounds.

EATON SHELL CORING



The Eaton process of Shell Coring in permanent mold and shell molded castings provides better internal surface finish and higher dimensional accuracy. Where more than ordinary quality and control of contour are required, the Eaton process offers distinct design advantages and greater uniformity in intricately cored sections.

EATON SHELL MOLDING



Eaton Shell Molding provides more closely controlled metallurgy and hardness for applications requiring pearlitic structures, close dimensional control, and complex designs and contours. Eaton Shell Mold Castings require less machining and finishing, with resulting savings in material, tooling, and shipping.

Send for Illustrated Descriptive Literature

EATON MANUFACTURING COMPANY
FOUNDRY DIVISION
VASSAR, MICHIGAN

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have you seen all that's new in gleaming stainless steel?

Now, leading department stores everywhere are showing gleaming, carefree Stainless Steel in new and exciting displays. See these shining examples of Stainless Steel kitchenware, tableware, utensils and appliances to make your living easier. *McLouth Steel Corporation, Detroit 17, Michigan*

McLOUTH STAINLESS STEEL

Special Ray-BOND® Adhesive

BONDS GLASS TO PLASTIC

To reduce breakage and assembly time of glass vacuum bottle fillers, The American Thermos Products Company, Norwich, Connecticut, undertook to replace an aluminum cap with a polyethylene protector for the evacuation tip of the glass filler.

The problem was bonding the traction-free polyethylene to the smooth glass surface. Existing adhesives couldn't do the job. R/M adhesive specialists, working closely with Thermos Company engineers, quickly developed a special adhesive.

The result is a superior bonding agent, R/M's new R-84002, for "Mylar," polyethylene, glass and other slick-surface, bond-resistant materials. Based on a thermoplastic synthetic resin, R-84002 has temperature tolerances ranging from −20 to +200°F.

Regardless of your application Ray-BOND adhesives of new or existing formulations can be tailored to your special bonding, laminating, sealing or coating requirement. Your costs are reduced; your production is improved. Let us prove this to your satisfaction. Call on Raybestos-Manhattan engineers today without obligation.

R/M Bulletin No. 700 contains helpful engineering information on Ray-BOND adhesives, protective coatings and sealers, and casting, encapsulating and potting compounds. Write for your free copy.

RAYBESTOS-MANHATTAN, INC.

ADHESIVES DEPARTMENT, Bridgeport, Conn. • Chicago 31 • Detroit 2 • Cleveland 16 • Los Angeles 58

RM

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For more information, circle No. 440 ➤

working with

Du Pont Zytel®

one of Du Pont's versatile engineering materials

Simplify designs ... save money with molded parts of Du Pont ZYTEL® nylon resins

The outstanding properties of parts made of ZYTEL nylon resins have led to the creation of simplified, money-saving designs. Typical of such improvements is the new Scotch Brand cellophane tape dispensing machine. Here, molded gears and shafts of ZYTEL replace more expensive machined steel parts. The intricate components of ZYTEL are easily molded to close tolerances and possess high strength and excellent wear resistance. Because of the low coefficient of friction of ZYTEL, these new parts eliminate the need for bearings, giving smooth, lubrication-free operation while saving money. And the parts of ZYTEL are much lighter than those previously used. For more examples of how ZYTEL nylon resins save money and simplify designs, look on the following page.

Tape dispenser by Specialty Manufacturing Co. for Minnesota Mining and Manufacturing Co., both of St. Paul, Minneapolis. Components of ZYTEL *molded by Northwest Plastics, Inc., St. Paul, Minnesota.*

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING

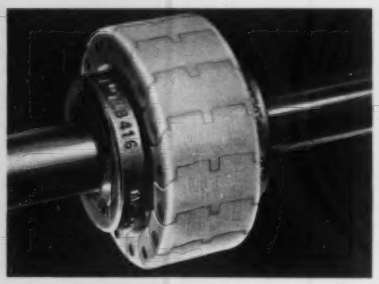
. . . THROUGH CHEMISTRY

working with

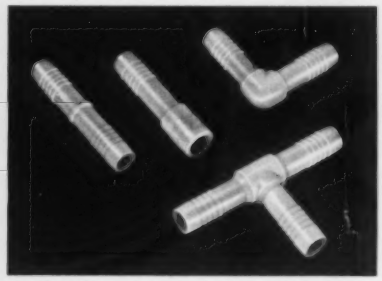
Du Pont Zytel®

one of Du Pont's versatile engineering materials

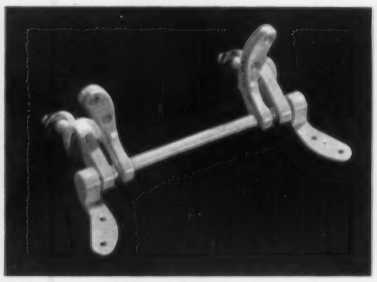
Complex moldings of ZYTEL® resist wear... corrosion... low temperatures



FLEXIBLE COUPLING made of links of ZYTEL outlasts metal chain coupling up to 6 to 1 and costs 20% less to buy and maintain. Coupling is clean, quiet, corrosive-free. (By Berea Plastics Co., Berea, O., for Morse Chain Co., Ithaca, New York.)



PIPE FITTINGS molded of ZYTEL are used to connect plastic pipe with plastic or metal pipe. Pressure grooving and threads are molded into the complex hollow shapes. The parts have high strength and chemical resistance. (By Yardley Plastics Co., Columbus, O.)



TOILET-SEAT HINGE made of ZYTEL is virtually indestructible . . . noncorrosive, rustproof . . . highly resistant to stain or discoloration. Easy-to-clean hinge never peels, cracks or chips. (By Bemis Manufacturing Corp., Sheboygan Falls, Wisconsin.)

When parts of any kind are subjected to rugged treatment, moldings of ZYTEL nylon resins usually give longer wear at lower cost. Because of an unusual combination of properties, parts of ZYTEL are equipped to withstand conditions that would reduce the life of ordinary materials. ZYTEL is easily molded into complex shapes and has exceptionally high strength in thin sections. Its resistance to temperature extremes allows reliable use under such conditions. Resisting corrosion, ZYTEL is ideal for use requiring exposure to the elements or to chemicals. Light in weight, it resists abrasion and impact. Du Pont ZYTEL may help you save money by reducing production costs and giving improved performance under adverse conditions. Find out how by filling out and sending in the coupon below.

POLYCHEMICALS DEPARTMENT

DU PONT

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Better Things for Better Living... *through Chemistry*

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Please send me more information on Du Pont ZYTEL. I am interested in evaluating this material for:_____

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Company_____

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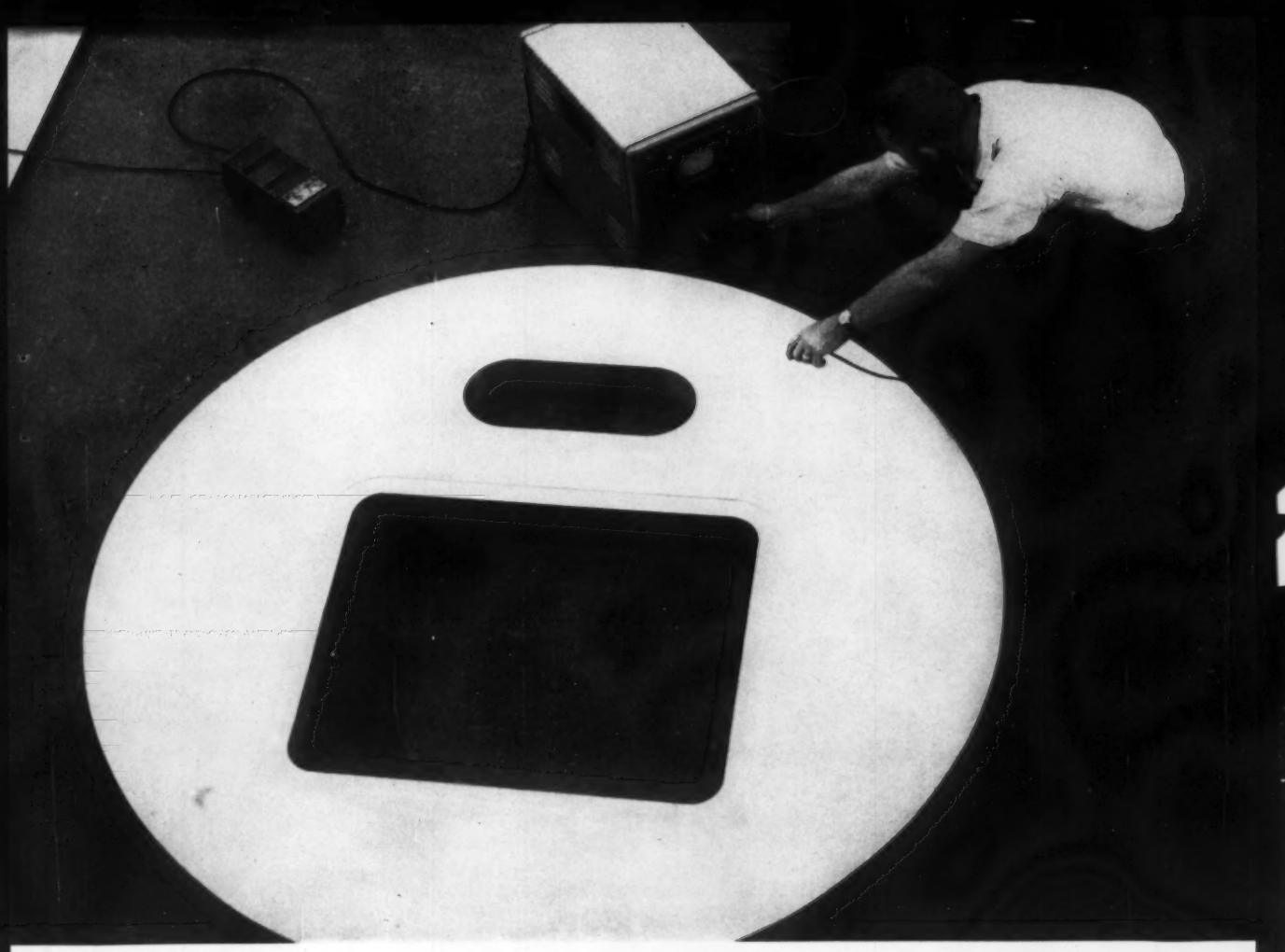
In Canada: Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec.

ZYTEL® *nylon resins*

one of Du Pont's versatile engineering materials

Alathon® · Delrin® · Lucite®



"test soundings"

. . . prove the soundness of Carlson stainless steel plate

"HEAVING THE LEAD" may be the traditional way to keep a boat off the shoals, but modern sound wave instruments do it faster and better. And, for a very different reason, modern sound wave devices are used to assure quality stainless steels. Carlson was one of the first producers to use ultra-sonic equipment for testing heavy gauge stainless plate.

In ultra-sonic testing, sound waves take a penetrating look inside and positively determine structural quality. A complete report on the results of the test is supplied to the customer. By specifying ultra-sonic tested plate, builders of aircraft components and nuclear equipment can tell in advance that the material will meet their rigid requirements.

Ultra-sonic is only one of the many tests used to maintain the high quality of Carlson stainless plate. The final, and most important test, is when *you* get repeat orders from *your* customers.

Write, wire or phone for complete information on all Carlson services.

G.O.CARLSON Inc.

Stainless Steels Exclusively

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THORNDALE, PENNSYLVANIA
District Sales Offices in Principal Cities

PLATES • PLATE PRODUCTS • HEADS • RINGS • CIRCLES • FLANGES • FORGINGS • BARS AND SHEETS (No. 1 Finish)

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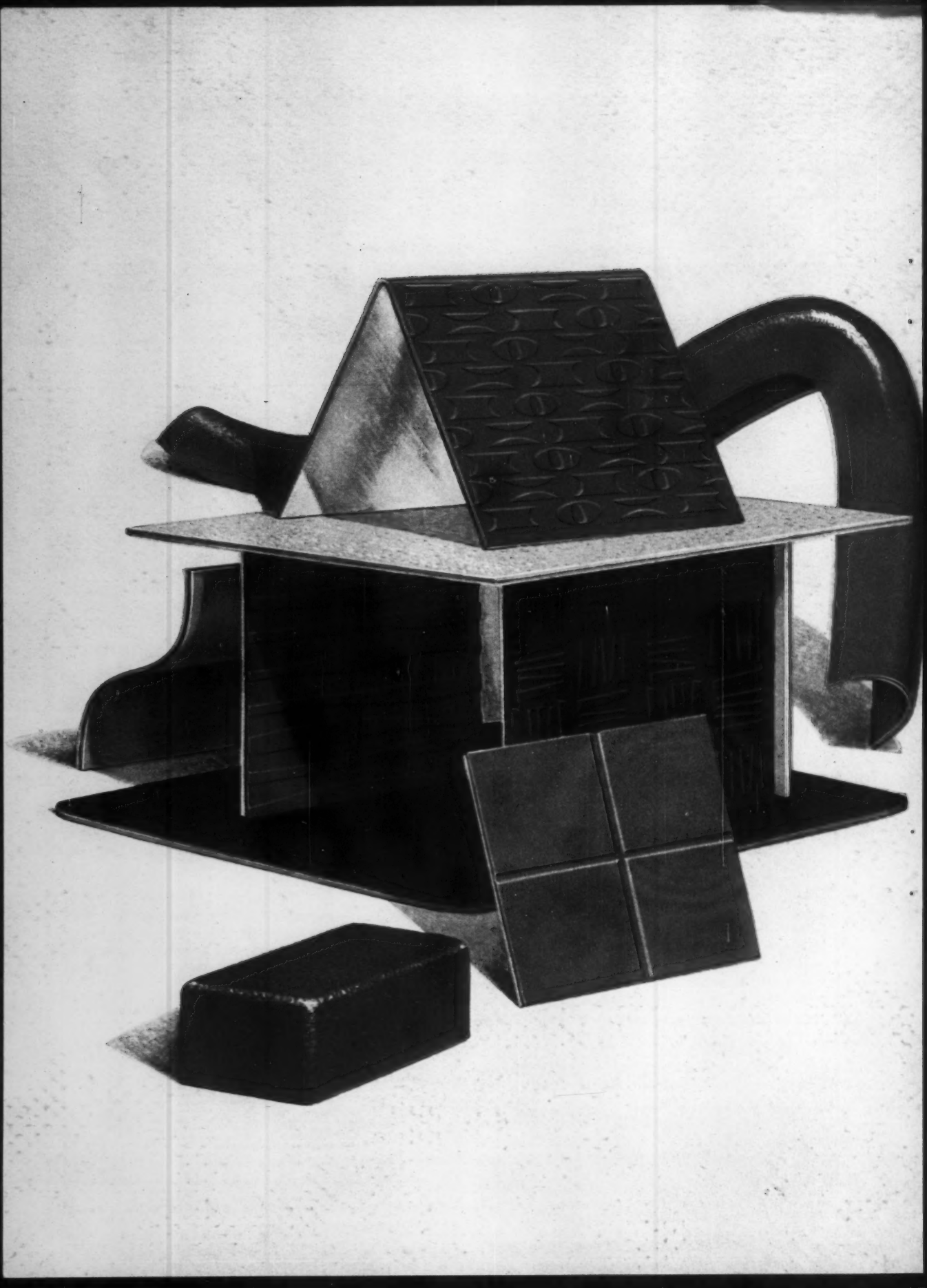


The strength of metal,

the decorative beauty

and protection of plastics . . .

Vinyl-on-Metal is a marriage of materials that creates new dimensions in form, color, and texture . . . presenting new combinations of properties that can improve existing products or inspire new ones. Both tough and attractive, it is low in cost, easy to fabricate. Vinyl-on-Metal is already being successfully used for TV cabinets, airplane and automobile interiors, luggage, typewriter cases, radio sets, card tables and chairs, interior and exterior wall partitions.

Vinyl-on-Metal offers

COLOR: a wide range of colors, all fast with minimum fading

FINISH: thick, resilient and cushioned; thin, hard and smooth; or highly decorative textures; glossy, dull, or pattern embossed

ABRASION RESISTANCE: mar and scratch resistant, long wearing

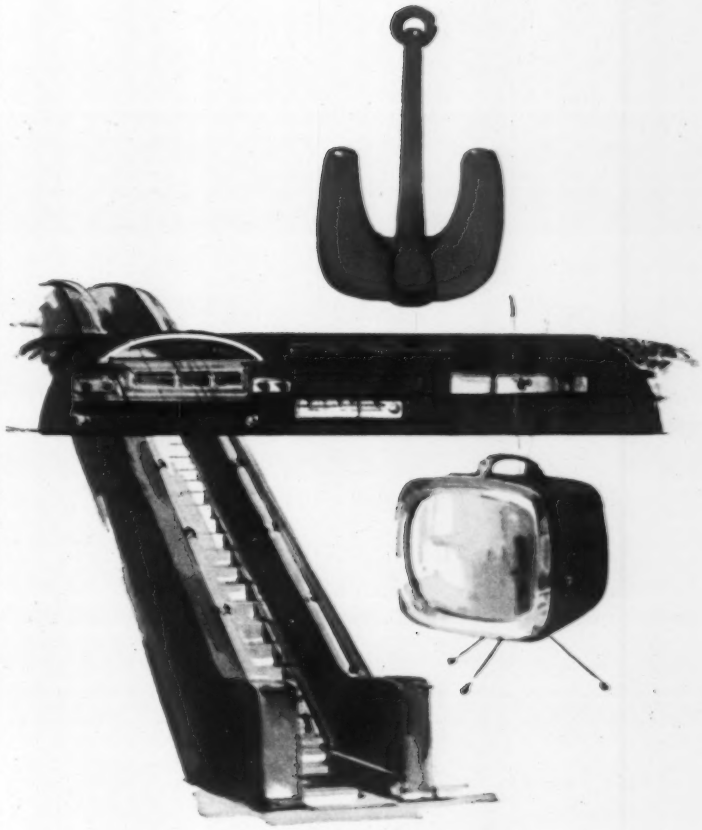
CHEMICAL RESISTANCE: resistant to acid corrosion, alkali attack, oxidation

MOISTURE RESISTANCE: resistant to water, washable with soap and water

WEATHER RESISTANCE: resistant to prolonged exposure to industrial atmosphere and accelerated weathering tests

EASE OF FABRICATION: can be formed, stamped, bent, punched, even welded into major components, eliminating almost all post-forming finishing

For handy reference booklet on Vinyl-on-Metal, write to Monsanto Chemical Company, Plastics Division, Room 1400, Springfield 2, Massachusetts.



MONSANTO INITIATOR IN PLASTICS

Monsanto

Monsanto Opalon® and Ultron® vinyls are the basic materials for superior vinyl finishes on metal, wood, paper, and glass.

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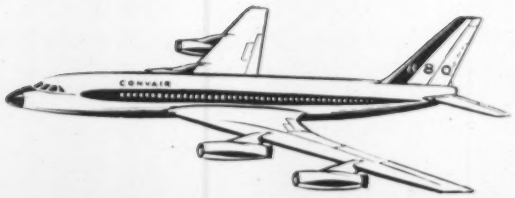

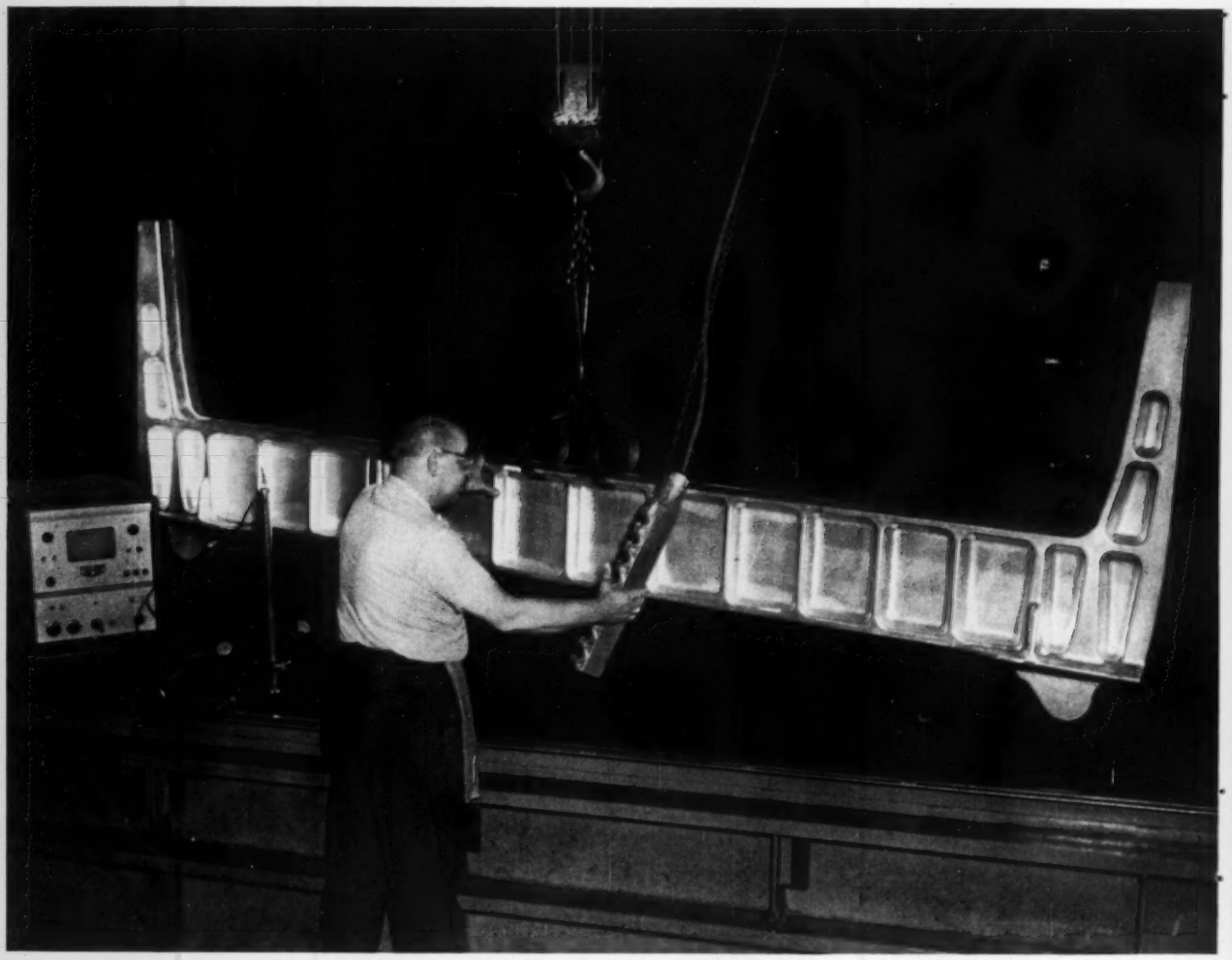

Largest closed-die forging ever made for commercial aircraft

The forging of these 657 lb. bulkheads presented unusual problems—problems of die design, of forging, and of handling. The successful solution of these problems saved a costly assembly of many smaller parts—costly both in terms of dollars and pounds.

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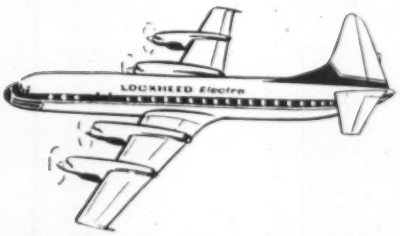

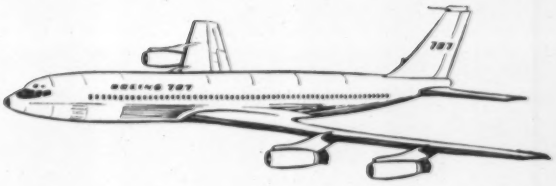

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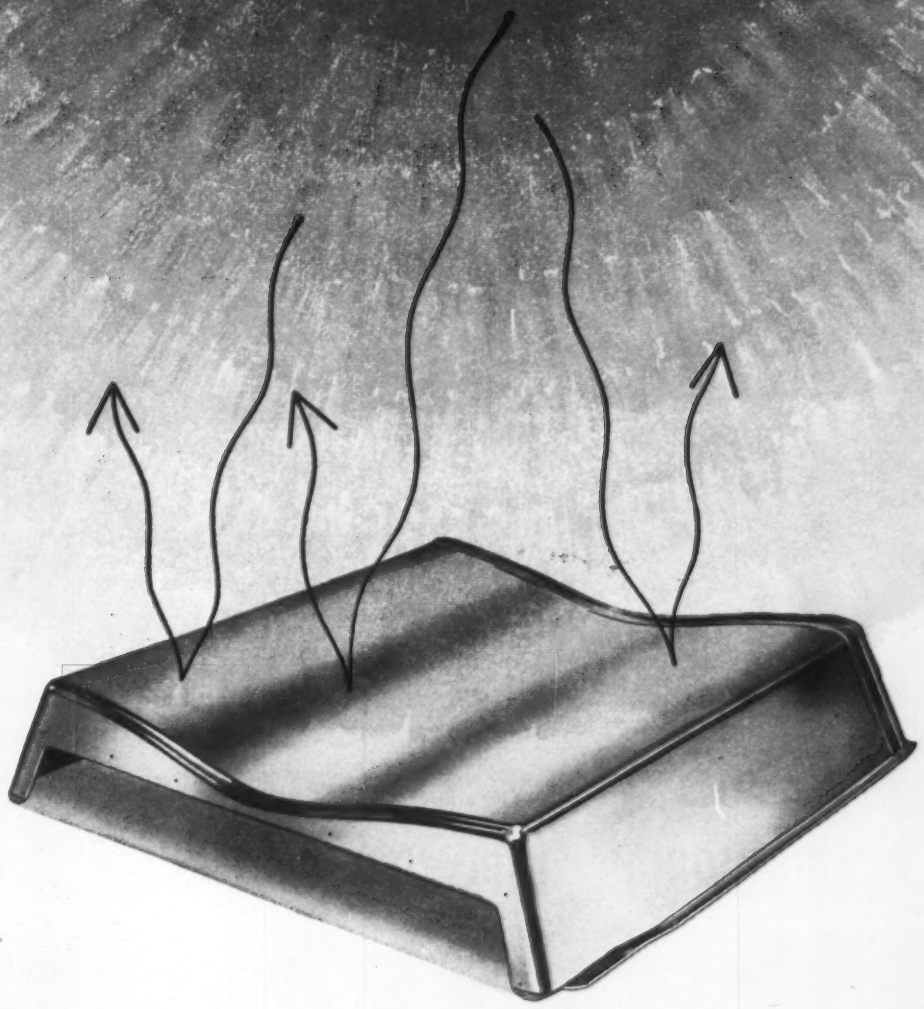

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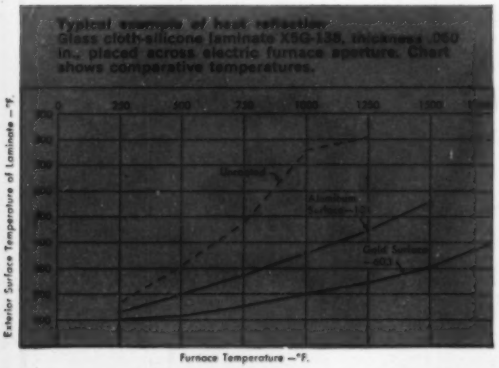
Typical example of heat reflection. Glass cloth-silicone laminate XSG-138, thickness .060 in., placed across electric furnace aperture. Chart shows comparative temperatures.
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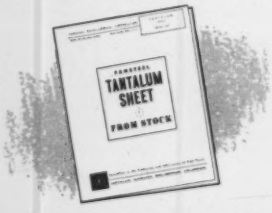

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...AT A GLANCE

Alumina powder can be used to insulate transformers and other electrical components within hermetically sealed cans, replacing the more conventional semifluid materials such as mineral-filled asphalts that have been used in the past. Advantages: melting point of alumina (2700 F) is well above the operating temperatures of any electrical apparatus; it does not expand or contract to any noticeable extent under wide fluctuations of temperature; and it does not require curing as some plastics potting compounds do.

Source: L. W. Kirkwood and R. S. Key, Bell Telephone Laboratories, 463 West St., New York 14.

Most steels with Rockwell hardness over C30 are susceptible to hydrogen embrittlement, according to recent research. On the other hand, low alloy steels with hardness below C30, and nonferrous metals, generally resist hydrogen embrittlement.

Source: Rpt. No. 5392, U. S. Naval Research Laboratory, Washington, D. C.

Gaskets and linings made of Teflon 6 resin are acceptable for use in commercial dairy equipment, according to the Food and Drug Administration.

Source: E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

A device to sort different metals that look alike without costly, time consuming and complicated testing has been developed. The tester quickly differentiates between Inconel and stainless steel, Zircaloy-2 and zirconium, and Zircaloy-2 and hafnium. The device consists of a standard milliammeter with two leads—one ending in a clamp and the other in a small carbon steel file.

Source: General Electric Co., Knolls Atomic Power Laboratory, Schenectady 5, N. Y.

A 'three-pole' magnet is helping scientists find out how magnetism affects magnetic materials. The magnet is being applied particularly to lining up crystals of magnetic materials used as microwave circuit elements. These crystals are tiny magnets, but the magnetic north-south axis of each crystal is not parallel to its crystalline axis. The tri-polar magnet gets around this "discrepancy" by aligning the crystals in a single direction.

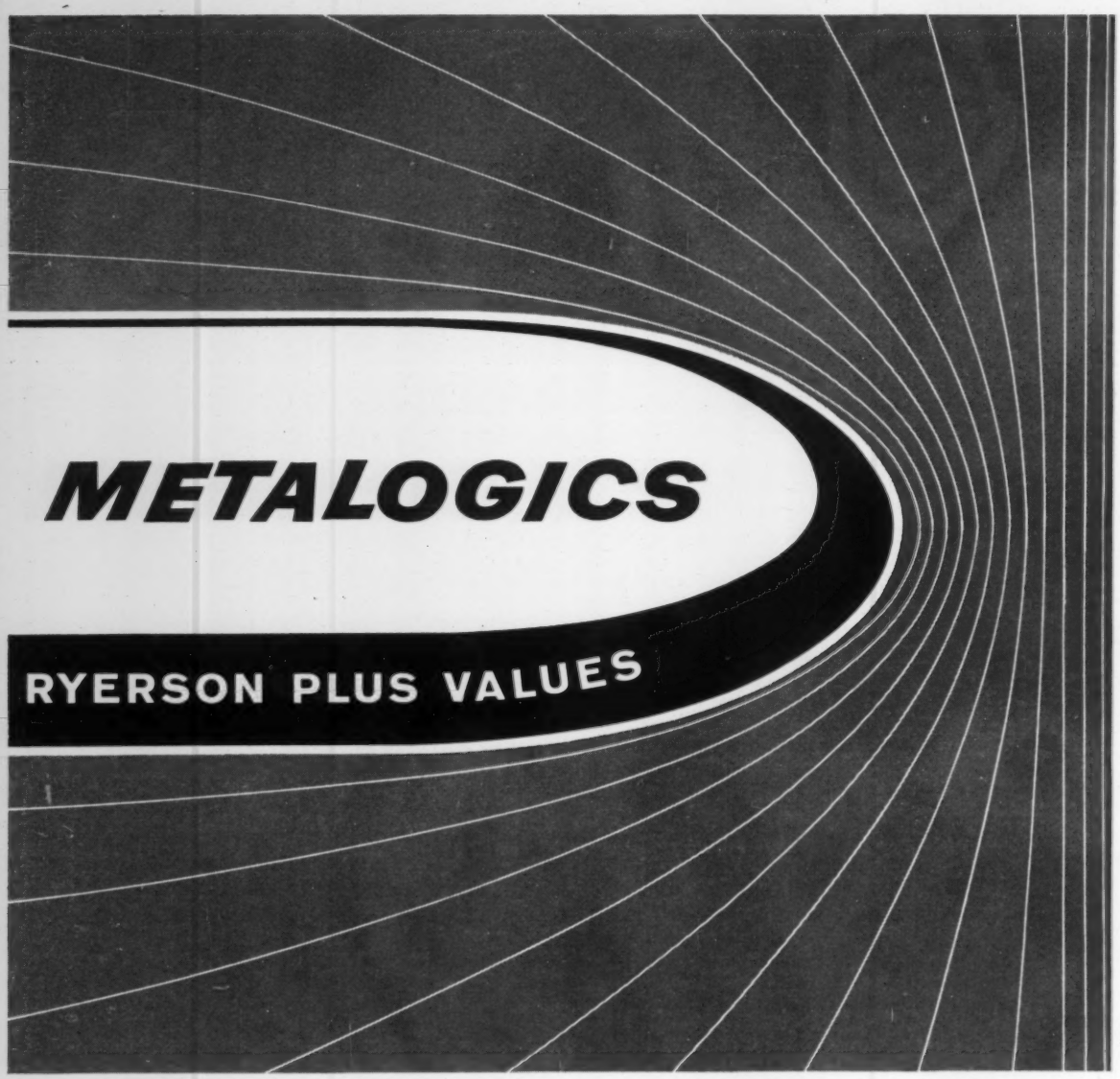
Source: D. M. Grimes, Electrical Engineering Dept., University of Michigan, Ann Arbor, Mich.

Mechanical properties of wood can be determined accurately and quickly by using vibrational nondestructive test methods, according to recent research. The tests, which use electronic sensing and computing devices, account for "invisible" differences in wood structure, and provide precise strength and stiffness classifications.

Source: B. A. Jayne, Washington State College, Pullman, Wash.

TFE resins look promising as expendable heat shields for rockets and missiles. Research shows an extremely thin TFE coating protects missile parts for as long as 2 min without heating a supporting metal sheet much beyond room temperature. Big advantage of a TFE heat shield is that it might permit the use of lightweight metals in missile construction, thus replacing presently used heavy metals and ceramics.

Source: E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.



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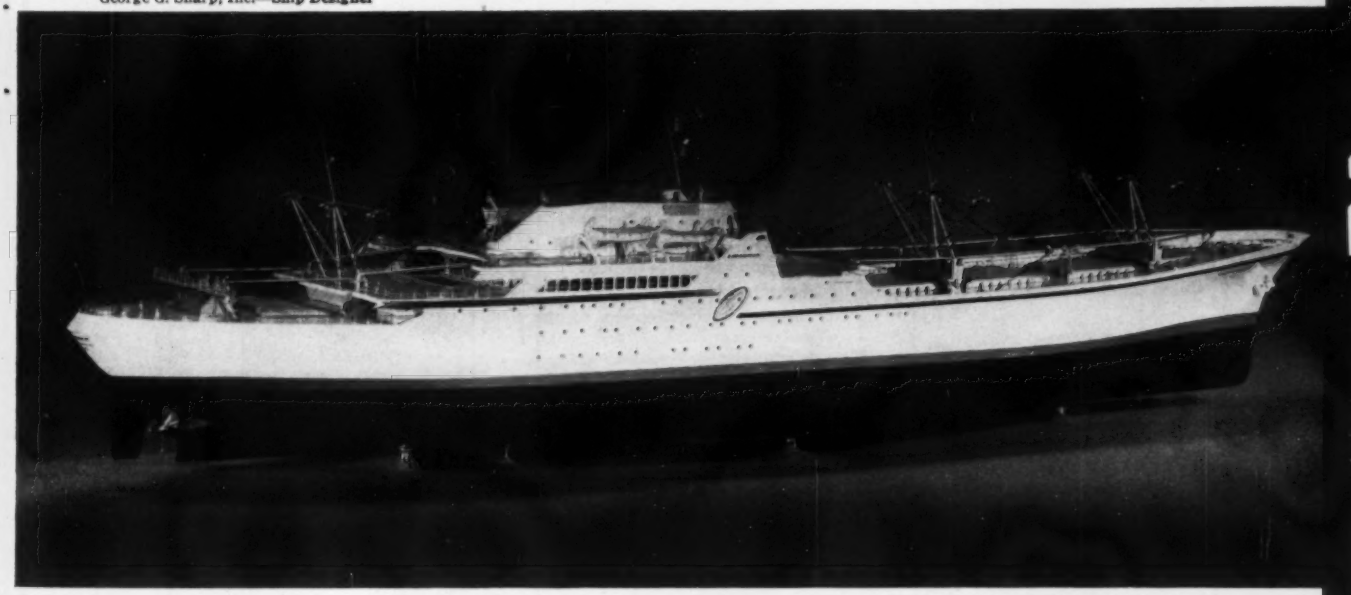


N. S. Savannah, *world's first nuclear-powered merchant ship, was launched last May and will be completed in 1961.*

Which Soft Solder for Nuclear Service?

Here is a summary of available information on vital nuclear parameters and solder properties.

by Alvin B. Kaufman, *Research Engineer, Litton Industries*

■ Factors which affect the selection and reliability of soft solders in nuclear service can be divided into two groups: environmental parameters and solder properties. The environmental parameters must be determined first because they dictate the degree of importance that must be attached to the property limitations of the solder.

Environmental parameters

These parameters fall into two categories: media and nuclear field. They are listed here for convenience, but full discussion of each parameter is beyond the scope of this article. The effect of solder properties will be discussed at length.

Media parameters are fully defined in military specification MIL-E-5272 and can be summarized as follows:

1. Humidity and salt spray.
2. Temperature.
3. Vibration.
4. Shock.
5. Acceleration.

Nuclear field parameters which must be considered in addition are:

1. Type of radiation (beta, gamma or neutron).
2. Quantity of radiation (dosage rate and time).
3. Energy level (Mev units).

Solder properties

Once the environmental parameters have been determined, the properties of the individual solders must be studied. To determine the extent to which a soldered connection in nuclear service will affect equipment service and maintenance, these properties must be considered:

1. Induced (artificial) radiation.
2. Tensile strength vs . . .
   a. Grain growth.
   b. Volume change.
   c. Density change.
3. Resistivity vs radiation.
4. Temperature effects.
5. Phase change vs radiation.
6. Corrosion resistance.

Studies to date have indicated that some of these properties may prove of vital importance and that the effects of others are negligible. Lack of data prohibits full discussion. However, enough can be said concerning each property to point out the need for selective care.

• *Induced (artificial) radiation.* The type and life characteristics of any induced (artificial) radiation in black box components and housing will determine the effect on serviceability and maintenance. For example, alpha and beta radiation can often be reduced to a workable level by the use of protective gloves, apron and face shield. Gamma radiation cannot. It thus becomes essential to employ materials that develop weak or no gamma radiation. If weak gamma radiation exists, it must be of short duration. Materials with large cross-section elements, such as cobalt, manganese and nickel, are to be avoided, since they capture more neutrons, thus resulting in more induced gamma radioactivity.

Although the solder connections in a black box are a small percentage of the total volume and density of the assembly, improper

A Brief Nuclear Glossary

Dosage. The total dosage and the rate at which it occurs determines the extent of induced radioactivity or component-element modification or damage. Total dosage is expressed as roentgens (r/hr x hr). Neutron flux integrated (nvt) is expressed as n per sq cm, i.e., the total number of neutrons per square centimeter which have bombarded a given area. Neutron flux is the major producer of induced radioactivity. Alpha and gamma do not produce radioactivity (see text); other particles produce radioactivity only under rare conditions.

Energy. Specified in ev or mev (millions of electron volts) of kinetic energy. This value, and the type of radiation, determines the ability to penetrate various substances, or to induce radioactivity.

Half-life. Specified in time. A half-life is the time it takes for half of the atoms in a quantity of a radioactive substance to undergo radioactive decay and become stable. Decay is exponential. A source with a 1-hr half-life will decay to one-half activity in 1 hr and to half of that in another hour.

Isotope. The smallest piece of an element that can still be considered as the element is called the atom. Atoms of a given element may vary in weight (mass) due to different numbers of neutrons in the atom nucleus. These different forms of the same element are called isotopes. Isotopes occur naturally, and are also created by nuclear bombardment. If the isotope is unstable it emits radiation (or particles) until the atom decomposes, by various modes, into a stable isotope.

Radiation rate. Generally, the disintegrations or particles emitted per second. Rate for alpha/beta/gamma is expressed in roentgens per hr. Neutron flux is expressed in n per sq cm-sec—the product of neutron density and speed.

Radioactive emission. Nuclear reactors generate many types of radiation, but due to integral shielding by reactor construction, emit gamma and fast neutrons only.

Alpha (α). High speed helium atom, positive charge. Attenuated rapidly by air or light shielding; little penetration.

Beta (β). Electron—a particle with a small mass and a negative charge. Moderate penetration of materials.

Proton. A particle with a large mass and a positive electrical charge.

Gamma (γ). A quantum of electromagnetic radiation emitted by an atom nucleus. Similar to x-ray. Energies range from 10^4 to 10^7 ev and are very penetrating. Thick shielding required for appreciable attenuation.

Neutron (n). A particle with a large mass and no electrical charge. In ordinary use, neutrons are spoken of as "fast," "slow," or "thermal." Fast neutrons have energies ranging from tens of Kev to more than 10^5 Kev and are very penetrating. Slow neutrons have lower energies and include thermal neutrons, which most commonly have a kinetic energy of about 0.025 ev.

solder selection could create a personnel hazard and service problem. Copper componentry does not have a long half-life, whereas some soft solder constituents have such a long life as to impair immediate serviceability. The accompanying table lists the main constituents and contaminants found in solder alloys of various types and gives data on the nuclear properties that may affect solder service.

The isotopes listed are not complete or fully comprehensive, but are representative of those which are significant with respect to service and maintenance. Unfortunately, the abundance of the radioisotope and its radiation particle, energy and half-life do not tell the whole story. But the data listed are all that is available in unclassified literature. Parameters of flux field intensity vs induced radiation and vs induced flux field intensity are not listed.

The neutron flux intensity which exists in the field appears to be an important variable in the production of radioisotopes and metallurgical changes. Preliminary experiments have indicated that aluminum and beryllium are sensitive to high flux only. Semiconductors and some other materials exhibit a self-healing property under low flux radiation. Thus the degree of induced changes in materials should be correlated with various flux levels.

A high artificial energy level may mean little. The induced radiation for a given mass may be one milliroentgen per hour or one roentgen per hour. This is why some isotopes are considered unimportant even though their half-life may be quite long.

• *Tensile strength.* Grain size changes in copper and nickel under nuclear irradiation have been reported. The effect on tensile strength has not been reported directly for most solder materials and alloys. Annealing following radiation has modified the extent of reaction. Most materials tested do not exhibit grain size changes.

Volume and density changes of materials have also been reported. However, the net result of irradiation is generally an improvement in the metallurgical characteristics of the material with respect to strength. These changes do not appear significant for the solder user.

• *Resistivity.* The changes in resistivity of many metals which have been observed after extensive irradiation at room tempera-

Best Solder for Nuclear Service

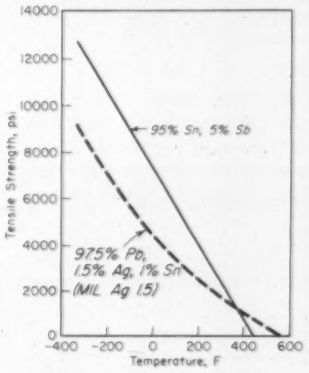
The graph depicts the tensile strength characteristics of the soft solder which appears to have the best composition for nuclear field service. The choice is based on factors discussed in this article. The solder consists of 97.5% lead, 1½% silver and 1% tin and is designated by military specifications as MIL Ag 1.5. Its tensile strength is satisfactory at much higher temperatures than the rating of available electronic hardware.

The graph compares this optimum solder with MIL-Sb5 (95% tin, 5% antimony) which does have higher tensile strength. This tin-base solder, however, has sharply decreasing impact strength at low temperatures, whereas the optimum solder has a higher and increasing impact strength.

MIL Ag 1.5 profits from the 1% tin content which performs two functions: it allows the solder to wet and tin easily, and also increases the corrosion resistance. The binary lead-silver solders do not possess these properties.

The high percentage of lead retards phase transformation. This effect is largely due to the percentages of bismuth and antimony which are contained in commercially pure lead.

The small percentage of tin used should not create a radiological or serviceability problem, although there are difficulties encountered with tin in nuclear service, as discussed in this article. The lead and silver have induced isotope half-lives of 3.3 hr and 2.3 min, respectively, and these half-lives are short enough to be satisfactory.



***Optimum solder** for nuclear service appears to be the lead-base solder MIL Ag 1.5, here compared with a typical tin-base solder.*

NUCLEAR PROPERTIES OF SOLDER ALLOY ELEMENTS

Material	Radioactive Isotope	Half-Life	Particle and Energy, mev
Cadmium	Cd^{113}	5.1 yr	β0.5
	Cd^{115}	2.3 days	β0.46, 1.1; γ0.52
Copper	Cu^{64}	12.8 hr	β+0.57; γ1.34
	Cu^{67}	58.5 hr	β0.54
Lead	Pb^{203}	3.3 hr	β0.68
Silver	Ag^{110}	253 days	γ0.66, 0.89
Tin	Sn^{113}	70-118 days	γ0.26, 0.4
Zinc	Zn^{65}	250 days	β0.4; γ0.45, 1.14
Antimony	Sb^{124}	60 days	β3.2, 0.6 γ1.7, 0.6
Indium	In^{114}	49 days	γ0.72, 0.56

ture are quite small and of little technological significance. In general, significant changes are found only at cryogenic temperatures, with high melting point metals most affected. Resistivity changes produced in a low temperature environment (–315 to –425 F) usually disappear upon return to room temperature.

Many materials do not exhibit any change in resistivity. Pure aluminum displays no measurable change at room temperature, and copper a resistivity increase of only 0.1-0.4%. The high temperature material, commercial molybdenum, exhibits a substantial resistivity increase (22%) after nuclear radiation of 5 to 6 $\times 10^{20}$ nvt at 194 F. In one case, commercial copper exhibited a 7.3% increase in resistance. This larger change, which should not occur in copper, may have been due to impurity content. Soft solder alloys have comparatively low melting temperatures and therefore should not change resistance enough for it to be an important consideration except in unusual circumstances.

• *Temperature.* The use of tin-lead soft solder, without additives, is not recommended for cold environments (which may accompany nuclear service) because of allotropic changes in the tin. The tin may change phase from its white to its gray form and become crumbly, with a large volume change. This will result in an open circuit and loss of hermetic seal. The addition of any one of several additives, such as antimony, inhibits such transformation. The speed and optimum temperature for tin transformation has been studied with pure white tin, and tin seeded with gray (alpha) tin. Reaction is fastest with "seeded" tin.

• *Phase change.* The action of nuclear radiation on tin has been studied. White tin (beta), upon neutron irradiation, transforms to gray tin (alpha) similar to samples "seeded" with gray tin. For example, a sample was irradiated at –315 F (liquid nitrogen –321 F) and the transformation measured by dilatometry at the temperature of the transformation reaction (–50.8 F). During the irradiation itself no gray tin is formed, as shown by x-ray diffraction at –315 F. Neutron irradiation thus can be used to produce uniform nucleation.

Electron (beta) irradiation (3.5 $\times 10^{18}$ electrons per sq cm at –319 F) and quenching does not produce transformation in specimens held in the transformation range for a week. Apparently the single point defects produced are insufficient, or the temperature not optimum, for fast transformation. Storage time was definitely too short for adequate evaluation. Up to a year is required for transformation under some alloy and temperature conditions. The purity of the tin used for test is also important, as little as 0.002% antimony preventing transformation of "seeded" tin in a seven-month test. The significance of electron (beta) irradiation is thus somewhat doubtful. As for gamma irradiation, gamma will produce radioactivity—but only when extremely high levels exist. It is therefore not considered as a radiating source for the production of radioactivity.

The effect of a tin soft-solder additive in preventing phase transformation due to nuclear or electron irradiation is unknown at present. With proper selection such an additive might be quite effective.

• *Corrosion resistance.* Normally metals and alloys are not subject to damage by ionizing radiation. However, if adjacent to materials sensitive to ionization, the increased chemical activity may cause increased reaction, i.e., corrosion.

Nuclear hazards

Soft solders do not appear to be a nuclear hazard under controlled conditions of limited exposure and limited quantities. As an example, a 10-gm mass of Ag 1.5 solder irradiated for 60 days with thermal neutrons of 107 n/sq cm/sec would subsequently be radioactive to the following extent: 0.8 $\times 10^{-3}$ milliroentgens per hr at 1 ft. At 1 cm, however, the dosage rate would increase approximately by a factor of 1000 and could become hazardous.

Lead and high-tin-content solders do not become highly radioactive under nuclear bombardment. However, dosages, etc., are relative, not absolute. What is excessive for one group or use may not be excessive for another group or operation. For example, the body extremities can withstand higher radiation than the body as a whole, without damage or fatal results. Many of these parameters make a "go–no go" approach in the use of materials impossible. The overall picture must be seen, and use and health parameters established for each application.

The use of a tin-base soft solder should not be considered where servicing and maintenance work are required immediately after nuclear power shutdown or immediately after removal of the equipment from the nuclear field to a service area. One isotope of tin has a half-life of 250 days. Certain other solder alloy constituents such as cadmium are as bad or worse, as shown in the table.

Acknowledgment

The author wishes to acknowledge the helpfulness of Dr. Leonard B. Gardner in reviewing certain nuclear parameters presented.

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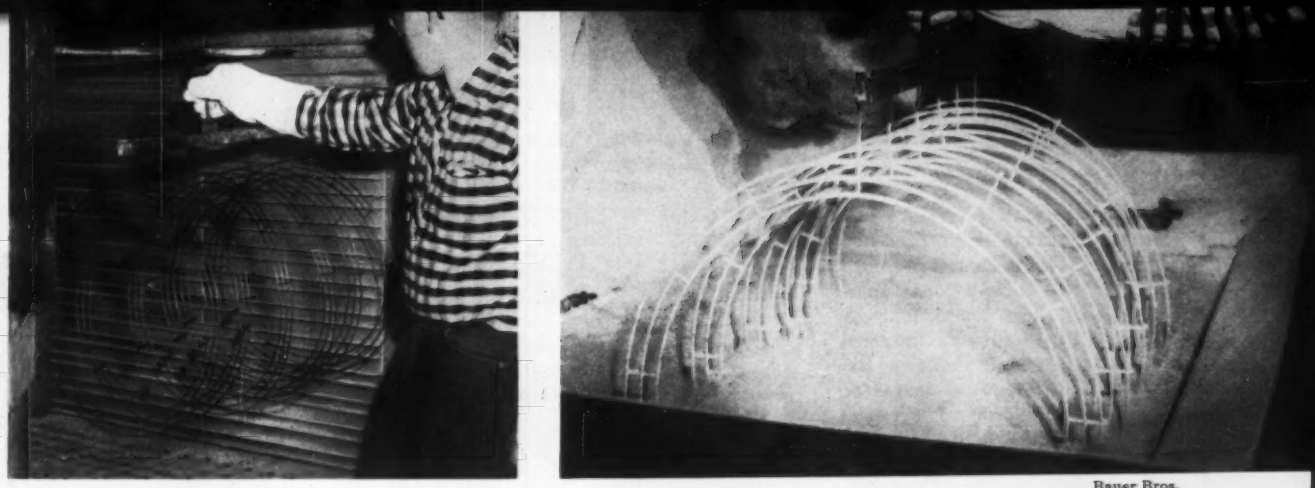

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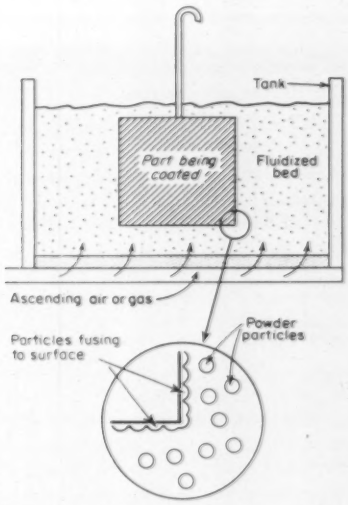
1 ***Two key steps*** *in applying coating are preheating of parts (wire clothes guards) above the melting point of the plastic (left), and immersion and movement of heated parts in fluidized bed of fine plastics powders (right).*

Fluidized Bed: Heavy Coatings in One Dip

Cellulosic • Vinyl • Epoxy • Nylon
Polyethylene • Chlorinated polyether

Coatings with uniform thickness and high quality are now being applied by the fluidized bed process. This up-to-date article tells you how the coatings perform and where they can be used.

by Walter R. Pascoe, *Technical Service Manager, Whirlclad Div., Polymer Corp.*



2 ***Simplified*** *diagram shows part in tank and closeup of particles forming on metal surfaces.*

How the coatings are applied

Parts to be coated are first preheated in an oven to a temperature above the melting point of the plastics coating material. The preheat temperature required depends on the type of plastic used, and the shape, mass and material of the part. Typical preheat temperatures required for various plastics are shown in Table 1.

After preheating (Fig 1) the parts are immersed and moved to and fro in a fluidized bed of the finely-divided plastic powders. Fluidization of the powders is produced by an ascending current of gas or air in the tank that contains the powders. While in the suspended state the powders behave—and even feel—just like a fluid.

When the individual powder particles contact the heated part they fuse and adhere to the surface (Fig 2). In many cases the part is post-heated to completely coalesce the coating and improve its appearance.

The thickness of the coating depends on the temperature of the part and how long it is immersed in the fluidized bed. Comparatively heavy finishes—from about 5 to 50 mils—are produced in a single dip.

TABLE 1—METAL PREHEAT TEMPERATURES (F) REQUIRED FOR FLUIDIZED BED COATINGS[a]

Cellulosic	500-750
Vinyl	375-550
Epoxy	250-400
Nylon	675-800
Polyethylene	300-800
Chlorinated Polyether	550-800

[a]Ranges represent temperatures required to obtain a continuous, uniform, pinhole-free coating.

Advantages of the process

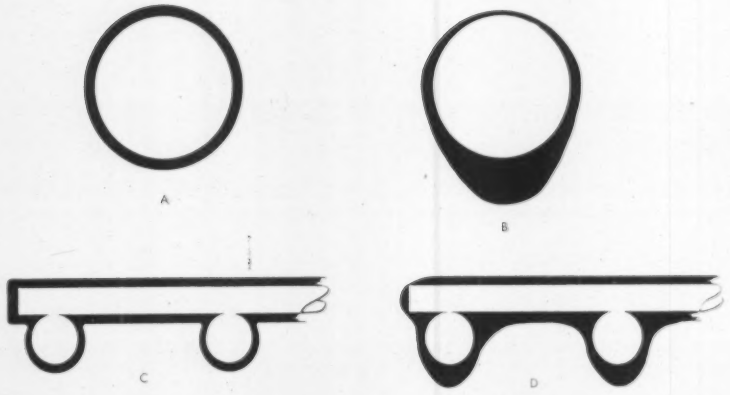
Coatings are uniform—An important advantage of fluidized bed coatings is that they are more uniform than conventional solution-type coatings. As sketches A and C in Fig 3 show, a fluidized bed coating closely follows the contours of irregular surfaces; it virtually eliminates excessive buildup, sagging and dripping, and it has good edge coverage.

These properties are illustrated by the wire product in Fig 4, which is quite difficult to finish. One immersion in a fluidized bed quickly and completely coats this complex part. As shown, there is no bridging of the coating, and all welded joints and sharp edges are uniformly coated.

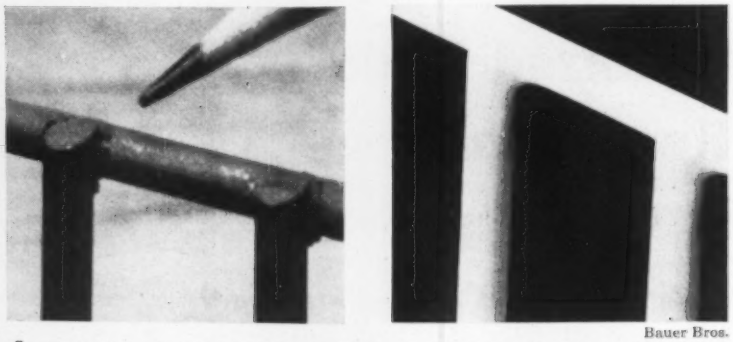
Difficult materials can be applied—The fluidized bed process is well suited for applying solvent resistant materials such as nylon and chlorinated polyether, which are difficult to apply by any other method. Thus, in some cases the advantages of a solid plastic can be obtained by using the material as a coating over a less expensive substrate. For example, the excellent corrosion resistance of chlorinated polyether can be obtained by applying the material on intricately shaped chemical processing parts. And the low friction properties, toughness and abrasion resistance of a nylon surface can be combined with the strength, rigidity and dimensional stability of a metal base.

Coatings have high quality—The quality of fluidized bed coatings is usually superior to that of equivalent solvent-type coatings. Although the coating materials may have higher initial cost than conventional materials, they may be cheaper to use in the long run. For example, one manufacturer was able to replace a high-grade alloy steel part with an inexpensive casting protected with a fluidized bed coating. The excellent adhesion and uniformity of the coating, coupled with its high corrosion resistance, produced a better quality product at substantial savings.

A wire products manufacturer has reported savings of $50,000 a year by using a fluidized bed coating instead of chromium plating. Previously, it was necessary to use a premium-priced, extra bright and clean wire to obtain a good electroplate. With the fluidized bed coating he was able to use a cheaper grade of wire and make a satisfactory product.



3 ***Uniformity*** *of fluidized bed coatings (A, C) is contrasted with conventional coatings (B, D) which tend to sag and to thin out at high spots.*



Bauer Bros.

4 ***Before and after*** *photos of wire rack show how sharp, unsightly joints are uniformly and decoratively coated by fluidized bed process.*

Six types of coatings—and their properties

Six different types of fluidized bed coatings are presently available—cellulosic, vinyl, epoxy, nylon, polyethylene and chlorinated polyether. The important properties of these coatings are summarized in Table 2. The cost ratios given are for an equal weight of material. The figures should be used with discretion as final cost of the coating will also depend on the specific gravity of the material and the thickness required for a given end use.

Cellulosic

Cellulosic fluidized bed coatings are noted for their all-around combination of properties and are especially popular for decorative-protective applications.

Appearance—Cellulosic coatings have excellent weathering properties, high luster and uniform texture, and can be made in an almost unlimited range of colors. They can be solvent etched to pro-

vide a satin finish if a dull or matte effect is desired, and they can be heat embossed for additional decorative effects.

Mechanical properties — Fluidized bed cellulosic coatings have good impact strength and, depending on their formulation, can be made resilient or rigid. They also have excellent scratch resistance and are relatively chip-proof. In fact, they are almost completely unaffected when struck with a ball peen hammer.

Electrical properties—The insulating properties of cellulosic coatings are good for low frequency applications below 160 F. Coatings 20 to 25 mils thick have an average dielectric strength of 1000 v per mil.

Thermal properties—Cellulosic coating resins generally have low heat distortion temperatures and should not be used over 140 F if subjected to loads (actual melting point of the resins is above 300 F). However, they can be used up to 160-180 F if not stressed.

Environmental resistance—Cellulosic coatings resist perspiration and salt solutions, are soluble in ketones and esters, and are softened by alcohol. They are relatively unaffected by petroleum hydrocarbons and many dilute alkalis, but are attacked by strong acids.

Cellulosic coatings have excellent weatherability and have successfully withstood accelerated tests consisting of exposure to salt water, abrasive dust, ultraviolet light and heat in cycles of 72 hr. Similarly, coated steel panels have been exposed for 3600 hr in a weatherometer with no apparent effect except for a very slight loss of gloss. After 6500 hr exposure in salt spray (Fed Spec L-P-406D, Method 6071-1) coated steel plates showed no loss of color and gloss and no evidence of edge corrosion.

Applications—The low cost of cellulosic coatings combined with their excellent appearance and durability are particularly useful on such applications as indoor and outdoor furniture, kitchen fixtures, home and marine hardware, metal stampings, fan guards, jigs and fixtures and sporting goods. Fig 5 shows an outdoor transformer housing cover that has been given a 15-mil cellulosic fluidized bed coating. The coating provides good electrical insulation and has high outdoor durability and an excellent appearance.

Vinyl

Vinyl fluidized bed coatings have a good combination of chemical resistance, colorability and gloss, flexibility and toughness, and low frequency insulating properties. And, as Table 2 shows, the resins are relatively inexpensive. They can be applied in thicknesses ranging from 5 to 60 mils (as compared to 10 to 100 mils for vinyl plastisols) and are claimed to have better uniformity and edge coverage than plastisol coatings. Conventional vinyl solution coatings, in comparison, are applied in thicknesses of 0.1 to 4 mils and, although they have uniform thickness, their edge coverage is relatively poor.

Mechanical properties — Vinyl fluidized bed coatings are distinguished for their resilience and

TABLE 2—PROPERTIES OF FLUIDIZED BED COATINGS[a]

Type →	Cellulosic	Vinyl	Epoxy	Nylon	Polyethylene	Chlorinated Polyether
CHEMICAL RESISTANCE						
Exterior Durability	E	VG	F	F	F	F
Salt Spray	E	E	E	G	E	E
Water (salt, fresh)	E	E	VG	F	E	E
Solvents						
Alcohols	F	E	E	G	E	E
Gasoline	G	E	E	E	VG	VG
Hydrocarbons	G	G	E	E	VG	E
Esters, Ketones	P	P	F	G	G	VG
Chlorinated	P	P	E	E	F	P
Salts	VG	E	E	VG	E	E
Ammonia	P	E	P	G	E	E
Alkalis	F	E	VG	G	VG	E
Mineral Acids						
Dilute[b]	G	E	E	F	E	E
Concentrated[c]	P	G	G	P	VG	E
Oxidizing Acids						
Dilute[b]	P	E	G	P	VG	E
Concentrated[c]	P	G	P	P	P	G
Organic Acids						
Acetic, Formic, etc	P	F	F	P	VG	E
Oleic, Stearic, etc	F	E	E	VG	VG	E
MECHANICAL AND PHYSICAL PROPERTIES						
Abrasion Resistance	VG	G	VG	E	F	VG
Flexibility	VG	E	P	G	E	F
Impact Resistance	E	E	G	E	F	G
Max Svc Temp, F	180	200	350+	180[b]	160	250
Dielectric Strength	G	G	E	G	E	E
DECORATIVE PROPERTIES						
Color Range[d]	U	U	L	L	U	L
Color Retention	E	VG	F	VG	VG	G
Initial Gloss	E	G	VG	G	VG	G
Gloss Retention	E	F	F	—	—	—
RELATIVE COST[e]	1.0	1.0	1.4	2.0	1.1	4.4

[a]These data are intended only as a preliminary selection guide. Final selection should be made after consulting with coating formulator and after suitable testing. Data are based on Corvel fusion bond coating as supplied by Polymer Corp. Key: E=excellent, VG=very good, G=good, F=fair, P=poor.

[b]Dilute=10%. [c]Conc=over 30%.

[d]U=unlimited (any color can be furnished); L=slightly limited (some difficulty in forming whites and pastels). Consult formulator for exact colors obtainable.

[e]For materials only. All costs are relative to vinyl which is assumed to have a value of 1.00. Thus epoxy materials cost 1.4 times as much as an equal weight of vinyl materials.

[f]Up to 300 F in nonoxidizing environment.

high impact resistance. They are available in many variations, from semi-rigid to highly flexible, rubber-like types. In general, the harder formulations have greater tensile strength than the softer types.

Electrical properties — Vinyl coatings have a dielectric strength of 600 to 800 v per mil and can be used as a general purpose insulation, particularly where good mechanical and chemical properties are also needed.

Thermal properties—Vinyl coatings have about the same resistance to heat as cellulosic coatings and are suitable for most applications at temperatures below 200 F.

Chemical resistance—As shown in Table 2, fluidized bed vinyl coatings have good resistance to weak acids and most alkalis. They are especially suited for coating wire products exposed to hot water and detergents, and provide excellent resistance against rust and underfilm corrosion.

Applications — Because of the properties outlined above, vinyl coatings have been especially successful on wire goods for appliances such as dishwashers, washing machines and refrigerators. They can also be used on wire furniture and hardware, and in industrial applications such as busbars, pump impellers, and conveyor rollers and other materials handling equipment. Cast iron, die castings and expanded metal parts can also be coated readily.

Epoxy

Fluidized bed epoxy coatings have a smooth hard surface and exceptionally good electrical insulation properties over a wide temperature range.

Mechanical properties — When properly applied, epoxy coatings have good impact resistance and do not sacrifice toughness for surface hardness.

Electrical properties—Following are typical short time dielectric strength values obtained with epoxy coatings at room temperature and 50% RH:

Thickness, mils	Dielec Str, v/mil
7	2300
10	1900
13	1400
25	1200

Even after immersion for 24 hr in water at room temperature the following values were obtained:

13 mils .....1350 v/mil
25 mils ..... 950 v/mil

Applications—Because of their good dielectric strength and uniform coverage over sharp edges, epoxy coatings have proved very useful as high quality, economical insulations on electric motor laminations. For example, the insulation cost of the pancake armature shown in Fig 6 was reduced more than 65% by using an epoxy coating instead of a seven-step fish paper and varnish system.

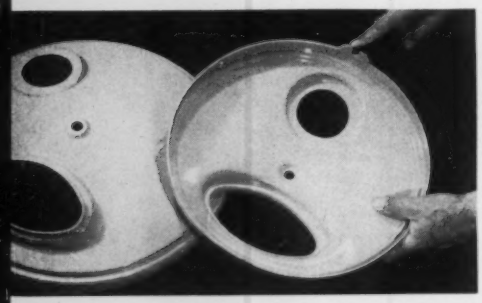
Nylon

Until a few years ago nylon could not be applied by any practical process, including solution coating techniques. However, the material can be applied by the fluidized bed process and, as the following properties show, offers many advantages to the designer.

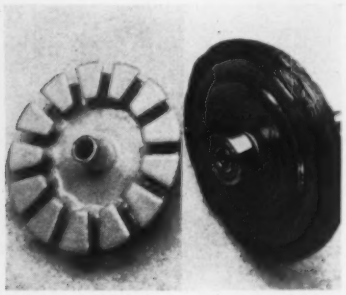
Mechanical properties — Nylon coatings are noted for their low surface friction and excellent bearing and wear properties. In addition to reducing friction they also minimize galling and scratching and cut down undesirable noise caused by metal-to-metal contact. Furthermore, the frictional heat developed in nylon is dissipated more rapidly when it is used as a coating over a conductive metal than when it is used as a solid plastics member.

Cold flow and creep problems encountered with solid nylon are also minimized by using the material over a strong metal base. In addition, cost savings may be realized by using nylon-coated metal instead of solid nylon. Because of their heavy thicknesses the coatings can be machined and precise tolerances maintained.

Electrical properties—The dielectric strength of nylon coatings is about 650 v per mil, based on a 10-mil thick coating. This is ade-

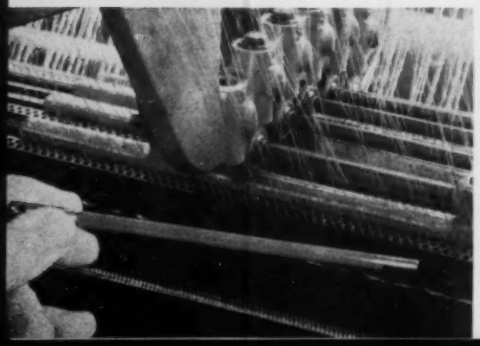


5 ***Outdoor transformer cover*** *is given a 15-mil thick cellulosic coating to improve weatherability, electrical insulation and appearance.*
Westinghouse Electric Corp.

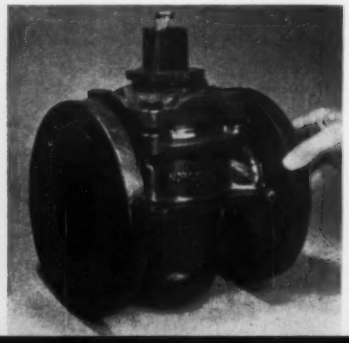


6 ***Pancake-type armature*** *is insulated with heavy epoxy coating which costs 65% less than previous fish paper and varnish system.*
Whittaker Controls Div., Telecomputing Corp.

7 ***Guide bar pin*** *used in knitting machine is coated with nylon to reduce friction and wear, and eliminate lubrication.*
Narrow Fabric Co.



8 ***Control valve*** *used in chemical processing equipment is given chlorinated polyether coating for corrosion protection.*
Rockwell Mfg. Co.



quate for some electrical applications.

Chemical resistance—Although they have outstanding solvent resistance, nylon coatings should not be used with strong mineral acids, nor with phenol or formic acids. The coatings can be steam sterilized and, when used with the proper primer, have sufficient adhesion to resist immersion in boiling water for up to 12 hr.

Applications — Nylon coatings are best suited for applications where low friction, little or no lubrication, and good bearing and wear properties are needed. Typical of such applications are bearings, collars, guides and slide valves for textile and farm equipment. Shown in Fig 7 is a nylon-coated guide bar pin used in a knitting machine. The base metal provides strength and rigidity, and the close-tolerance nylon coating cuts friction and wear and eliminates lubrication. Use of the coating has reduced lubrication costs $50 per month per machine and increased pin life 500%.

Although nylon is not normally considered a decorative material it has been economically used on rough cast iron handles, knobs and cranks. A black nylon coating has been used on high quality, modern indoor furniture to simulate a wrought iron finish. A similar coating has also proved useful on instrument panels.

Polyethylene

Polyethylene coatings have a good combination of mechanical and chemical resistance properties and can only be applied successfully in heavy thicknesses (10 to 60 mils) by the fluidized bed process. High quality coatings can also be applied from a newly developed series of water and solvent dispersions but such coatings must be baked and are relatively thin. Coatings can also be deposited by flame spraying but they are apt to be rough and contain discontinuities.

Electrical properties—Polyethylene coatings have a good combination of insulation properties, including low power factor and dielectric constant, and high resistivity and dielectric strength. Their short time dielectric strength ranges from 900 to 1200 v per mil.

Chemical resistance — Heavy polyethylene coatings applied by the fluidized bed process have zero water absorption, resist chemical attack by most acids, salts and alkalis, and are not affected by subzero temperatures in chemical applications.

Applications—The primary uses for polyethylene coatings are for protecting chemical processing equipment, and on food handling equipment where they are important in providing a relatively soft, hygienic, corrosion barrier. Typical chemical applications are pipes and fittings, pump and motor housings, valves, fans, and electroplating jigs, hooks and platforms.

Chlorinated polyether

Fluidized bed coatings formulated from chlorinated polyether powders are relatively new and have achieved rapid recognition because of an excellent combination of properties, as outlined below.

Mechanical properties—Chlorinated polyether coatings have very low cold flow and good resistance to deformation under load at high temperatures. They are also tough and have good resistance to wear and abrasion, yet can be easily machined and finished on standard metalworking and centerless grinding equipment.

Electrical properties—The coatings also have good insulation properties, even in high humidity and high temperature applications. Dielectric strength is about 1000 v per mil. They have better insulation properties than most thermoplastic coatings. They have low loss factors over a wide range of frequencies but should not be used at high frequencies.

Thermal properties—Chlorinated polyether coatings retain their properties at very low temperatures and up to 250 F and above. For example, coated parts have been used in oil for 8 months at 320 F with no sign of failure. The coatings are not recommended for continuous use above 250 F except if used in certain non-oxidizing atmospheres. Flammability tests indicate that the coatings are self-extinguishing.

Chemical resistance — Chlorinated polyether coatings have extremely low moisture absorption and resist most alkalis, solvents, chlorides and inorganic acids. However, they should not be used in contact with some chlorinated organic solvents, nor with fuming sulfuric and nitric acids.

The coatings successfully withstand many common plating solutions. Coated coils have been immersed in a solution of copper cyanide, sodium cyanide and caustic soda at 125 F for 1 week without any visible damage. (They also provide good insulation when used in electrolytes.) Although the coatings exhibit some softening they still retain their chemical resistance when immersed in such plating media as chromic acid, cyanide solutions, 15% sulfuric acid, alkali cleaners and phosphate solutions all at temperatures of about 190 F.

Applications—Because of their excellent chemical resistance, chlorinated polyether coatings can be used in processing equipment to protect relatively low cost metal parts. The control valve shown in Fig 8 (see also "New Ways to Combat Corrosion," M/DE, Sept '59, p 94) is a good example of this type of application. Because of their low moisture absorption the coatings can also be used on hot water equipment and parts requiring sterilization.

The wear and abrasion resistance of the coatings is expected to be useful on parts such as valves, pump impellers, cams and bushings, particularly in applications where chemicals and moisture are also encountered.

Author's note: The basic fluidized bed process was developed and patented in Germany by Knapsack-Griesheim A. G. of Frankfurt. Polymer's Whirlclad coating system which encompasses the fluidized bed technique is protected by various apparatus (Polymer also supplies the equipment required) and process patents in the United States and foreign countries. Exclusive patent and licensing rights in the United States and Canada are owned by a subsidiary of the Polymer Corp., and many custom coaters and manufacturing companies are licensed to apply the coatings.

Glass Bonded Mica

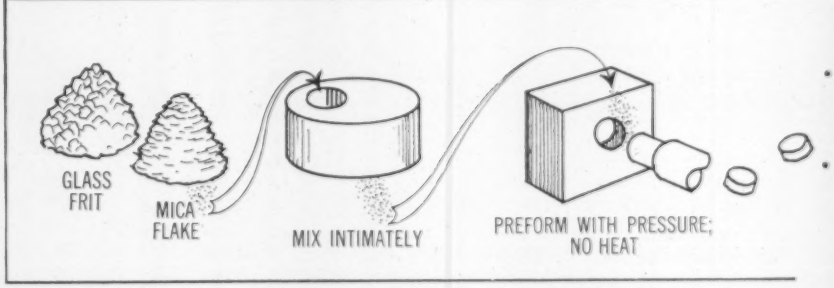
The properties of ceramics

the moldability of plastics

TABLE 1—MYCALEX V5

Material →	ASTM	Glass-Bonded Mica: Lightweight General Purpose	High Moldability	High Strength	High Temperature[a]
PHYSICAL PROPERTIES					
Specific Gravity	D792	2.64	3.89	2.65	2.94
Density, lb/cu in.		0.095	0.14	0.095	0.16
Ther Cond, Btu/hr/sqft/°F/ft	C177	0.23	0.31	0.23	0.23
Coef of Ther Exp, 10^{-6} per °F	D696	6.55	6.05	6.21	4.0
Specific Heat, Btu/lb/°F	D570	0.43	0.23	0.41	0.20
Water Absorption (24 hr), %	D570	Nil	Nil	Nil	Nil
Flammability, ipm	D635	None	None	None	None
MECHANICAL PROPERTIES					
Tensile Strength, 1000 psi	D638	6	6	6	6
Rockwell Hardness	D785	H91	H91	H91	H91
Impact Str (Izod Notched), ft-lb/in. notch	D256	0.6	0.7	1.6	0.6
Flexural Strength, 1000 psi	D790	13	13	19	13
Mod of Elast in Flex, 10^6 psi	D790	8.0	7.2	10	8
Compr Str, 1000 psi	D695	29	26	30	29
ELECTRICAL PROPERTIES					
Volume Resistivity, ohm-cm	D257	4×10^{12}	5×10^{12}	15×10^{12}	4.3×10^{14}
Surface Resistivity (dry), ohm		10^{16}	10^{16}	10^{16}	5.7×10^{12}
Dielectric Str (short time), v/mil	D149	340	320	400	350
Dielectric Constant (1 mc)	D150	6.9	9.2	6.6	6.7
Dissipation Factor (1 mc)	D150	0.0042	0.0078	0.002	0.002
Loss Factor (1 mc)	D150	0.028	0.072	0.015	0.014
Arc Resistance, sec	D495	240[d]	250[d]	250[d]	>300[d]
EFFECTS OF ENVIRONMENTS					
Max Cont Svc Temp, F		700	700	700	1000
Solvent Resistance		Exc	Exc	Exc	Exc
Acid Resistance		Poor	Poor	Poor	Poor
APPLICABLE MOLDING METHODS		Transfer	Transfer	Compression	Transfer

[a]Transfer molding grade.
[b]Heat resistant grades.
[c]Although variety of modified polystyrenes have greatly improved shock resistance, general purpose material has optimum electrical properties.



by John E. Faloon, *Taunton Div., Haveg Industries, Inc.*

■ The portion of the table on this page shows properties of four typical grades of glass-bonded mica. As the properties indicate, glass-mica is a high dielectric strength, low loss insulating material, usable over a wide temperature range.

Note that physical and electrical properties are most similar to those of electrical porcelain. But because glass-mica is formed by compression and transfer molding techniques similar to those used for plastics, the material offers the design benefits inherent in these processes.

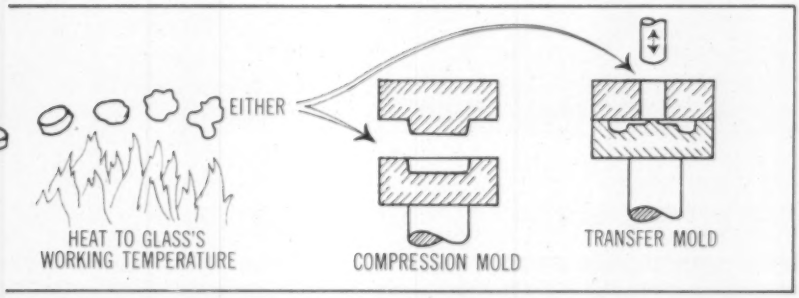
The most important advantages of glass-mica stem from the material's similarity to both ceramics and plastics. Briefly glass-mica's ceramic nature provides:

- Excellent dimensional stability on exposure to moisture or heat.
- Heat resistance approaching that of electrical ceramics.

OTHER DIELECTRICS

Electrical Porcelain	Thermosetting Plastics				Thermoplastics		
	Melamine (mineral-filled)	Phenolic (mineral-filled)[b]	Silicone (mineral-filled)	Alkyd (mineral-filled)	Polystyrene (genl purp)[c]	CFE Fluorocarbon	TFE Fluorocarbon
2.37-2.53	1.7-2.0	1.54-1.75	1.8-2.0	2.16-2.18	1.04-1.07	2.10-2.15	2.1-2.3
0.085-0.091	0.061-0.072	0.055-0.063	0.065-0.072	0.078-0.079	0.037-0.039	0.076-0.077	0.076-0.083
0.87-1.57	0.32-0.41	0.19-0.39	0.089-0.097	0.35-0.60	0.06-0.08	0.035-0.036[h]	0.034[h]
2.0	10.6-25.0	11.7	27.8-32.3	10-30	33-44	38.8	55
—	—	0.028-0.32	—	—	0.32-0.35	0.22	0.25
Nil	0.08-0.14	0.2-0.5	0.2-0.4	0.04-0.06	0.03-0.05	0.00	0.00
None	Self-Ext	Self-Ext	0-78	Self-Ext	1.0-1.5	None	None
2.5-7	5.5-7.0	4-6.5	4-4.3	3-4	5-8	4.6-5.7	1.5-3.0
—	M110	M98-115	M89	—	M68-80	R110-115	J75-95
—	0.3-0.4	0.2-0.4	0.3	0.3-0.4	0.25-0.35	3.5	3-4
5.4-12	8.7-11.0	3-10.5	6.8-7.5	7-10	8-15	—	1.6[i]
—	1.6	1-2	1-1.3	2.2-2.7	0.4-0.5	0.20-0.25	0.06
49-70	25-30	15-35	16-20	18-20	11.5-16	2.0[i]	0.7-1.8[i]
10^{13}-10^{15}	10^{11}-10^{13}	10^{11}-10^{12}	$>3.4 \times 10^{13}$	10^{14}	10^{18}-10^{19}	10^{18}	10^{19}
—	—	—	—	—	—	—	—
55-300	350-430	150-350	350-400	300-350	>500	530-600	400-500
5.4-7.0[e]	6.1-6.7	4.8-8.0	3.8-4.3	4.2-4.5	2.45-2.65	2.30-2.37	2.0
0.009-0.011[e]	0.04-0.05	0.04-0.15	0.006-0.010	0.014-0.015	0.0001-0.0005	0.007-0.010	0.0002
0.053-0.060[e]	—	—	0.023-0.043	—	—	—	—
—	120-170	5-120	250-420	180	—	>360	>200
1820	250-400	375-425	>450	300[f]	140-160[g]	380	500
—	Good	Variable	Variable	Good	Poor	Excellent	Excellent
—	Resists weak	Variable	Good	Good to weak	Poor	Excellent	Excellent
Ceramic forming techniques	Compression or transfer molding				Injection or compression molding, or extrusion		Compact and sinter

[d]Nontracking.
[e]60 cps.
[f]For limited periods.
[g]Up to 180 F for heat resistant grades.
[h]Cenco Finch.
[i]At 0.1% offset.



▶ High arc resistance; nontracking.

▶ Hardness of glass.

And the plastic moldability of glass-mica provides:

▶ Ability to mold-in complex inserts.

▶ Close tolerances on molded dimensions.

▶ Reproducibility of accurate dimensions and quality on a production basis.

In order to help in evaluating the characteristics of glass-mica in the light of specific design needs, the following sections discuss costs, physical and mechanical properties, electrical properties, and shape considerations. The discussions primarily compare glass-mica with electrical ceramics and electrical grades of seven plastics materials which might be competitive for a particular part.

Remember that the properties of glass-mica shown in the table represent only four typical grades. Many specific formulations can be prepared.

Costs hard to compare

In general, glass-mica parts are relatively expensive, but they offer premium properties. They should be used only where their characteristics are necessary.

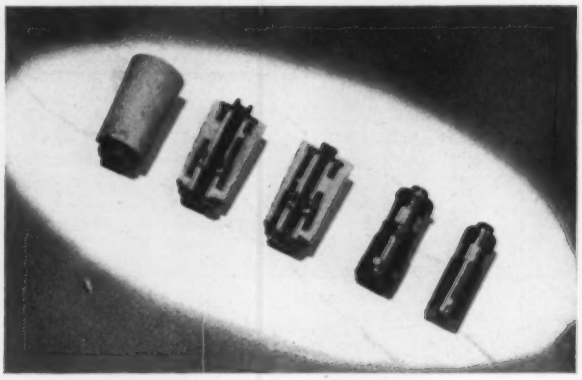
Actual cost of parts varies widely. It depends on:

1. Type of glass—usually a lead borate type, though other compositions may be used.

2. Type of mica—natural is generally used for lower tempera-

The proper grade of glass-mica provides . . .

Light weight—*These servo brush holders and connector inserts are designed for aircraft service; thus they are made of a lightweight grade of glass-mica.*



Excellent moldability—*This commutator for a servo motor illustrates the high moldability of some grades of glass-mica. Complete part is at left, in center are two cross sections, and at right are two parts machined down to show intricacy of insert.*

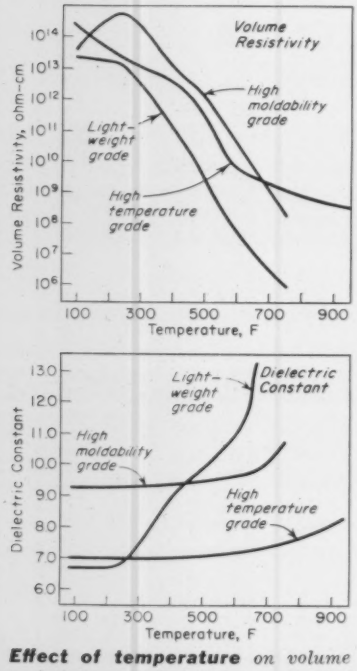
ture grades; synthetic for higher temperature grades.

3. Ratio of glass-to-mica—variable depending on end properties and type of molding technique.

4. Part size, shape, complexity, and number and type of inserts to be incorporated—affect such factors as tooling costs, cycle times and number of cavities in the mold.

5. Production volume—affects tool amortization, apportioning of fixed costs, etc.

All these variables are controlled by the custom molder to meet your specifications.



Effect of temperature *on volume resistivity and dielectric constant of three typical grades of glass-mica.*

Glass-mica is usually more expensive than the average plastics molding material, such as phenolic, melamine or alkyd. It is probably more comparable in cost to the fluorocarbons.

Also, materials costs of glass-mica are probably higher than those of most electrical ceramics. But the economies of production-molding glass-mica, and the additional costs of finishing ceramic parts, including location of inserts, etc., would often cancel out this difference. In some cases the glass-mica part would actually be less expensive.

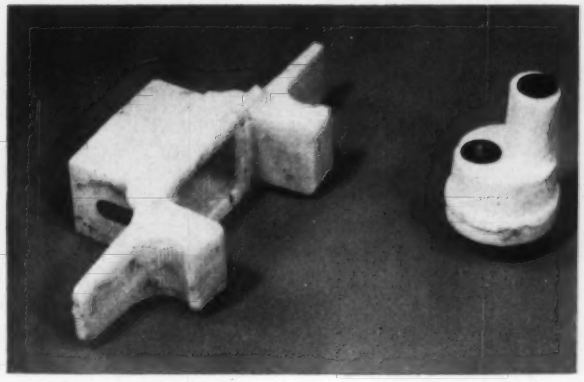
Physical and mechanical properties

Glass-mica is heavier than plastics, even in the lighter grades.

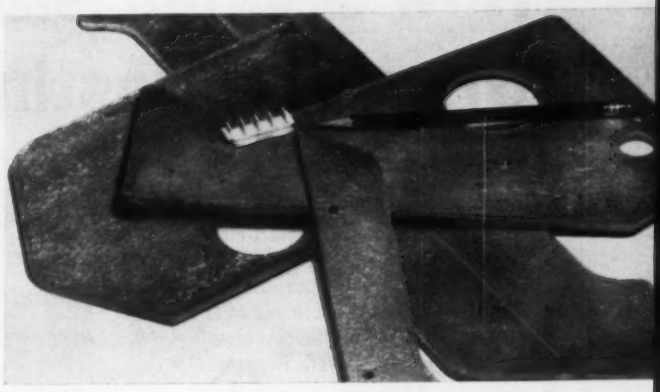
One of the prime attributes of the material is its dimensional stability over a wide range of temperatures and moisture conditions. It has negligible shrinkage on molding (some shrinkage is encountered in molding sections over 1 in. thick). Its negligible water absorption is otherwise common only to electrical porcelain and the fluorocarbons. Thermal expansion characteristics of glass-mica are somewhat higher than those of porcelain, which should result in poorer thermal shock resistance. Expansivity is substantially lower than that of the seven plastics. Consequently, dimensional change is relatively small. even at temperatures ranging up to the material's 700-1000 F maximum continuous service temperature.

In general, mechanical properties of glass-mica depend on the molding method, shape of the part, and the formulation. Compression molding provides higher impact and flexural strengths, and a higher modulus, than transfer molding. The reasons are better orientation of larger mica flakes and a higher ratio of glass to mica.

Glass-mica has the high rigidity, flexural strength and hardness common to ceramics. Impact strength is quite low, as would be expected. However, the mica flakes do provide a degree of reinforce-



***High temperature resistance**—High temperature grade is used for fuse housing, shown at left. Part has stainless steel inserts to which contacts must be oven-brazed. Fire detector part at right is used on jet aircraft and must withstand 1000 F.*



***High strength**—These switchgear plates and the small relay contact barrier are compression molded to provide maximum mechanical strength.*

TABLE 2—TOLERANCES FOR TRANSFER MOLDED PARTS•

Dimensions	Commercial	Special
Length, Width and Diameter, in.	±0.004, plus 0.001/in.	±0.002, plus 0.001/in.
Thickness Across Parting Line, in.	±0.005	±0.004
Flatness, in. per in. of length	±0.003	±0.002
Hole Center Distance, in.	±0.003, plus 0.001/in.	±0.002, plus 0.001/in.

•SPI Standard Tolerances for Mica-Filled Phenolic generally apply to transfer molded parts.

ment. Impact values shown for the plastics materials are not as high as can be attained, but are typical of grades having the best electrical properties.

Electrical properties

Probably the single most outstanding electrical property of glass-mica is its arc resistance. Also, because it is inorganic, when arcing does occur no carbonaceous path forms; thus the material is nontracking.

The high temperature stability and negligible moisture absorption provide stable electrical characteristics. The curves on p 98 show effect of temperature on volume resistivity and dielectric constant. In room temperature volume resistivity, dielectric strength and dielectric constant, glass-mica is comparable to most of the materials in the table. Only polystyrene and CFE and TFE fluorocarbons are substantially better in these properties. Loss characteristics are good—better than in the thermosets but not as good as in polystyrene and the fluorocarbons.

Design similar to plastics

General design recommendations for glass-mica are the same as those for good basic plastics design. The major differences result from the higher molding pressures (about twice those used for plastics) and the higher molding temperatures (600-1200 F). Part design must permit molds to be well supported and to provide for balanced part ejection.

Of the two molding techniques, transfer molding is probably more commonly used. It provides intricate parts with small through-holes and molded-in inserts. Compression molding is used only for relatively flat parts with consistent cross section. Usually, compression molded parts should not require inserts or small molded-in holes.

The negligible shrinkage of glass-mica permits accurate as-molded dimensions. Table 2 gives general dimensional tolerances obtainable. Lack of shrinkage also facilitates molding-in of highly intricate inserts. Inserts, particularly when massive, should have thermal expansion characteristics similar to those of glass-mica; hence metals such as nickel iron, stainless steels (403, 410, 416), platinum and monel. To provide maximum stability, inserts should be undercut or knurled.

Parts should be designed with as much draft as practical; at least ½ to 3 deg per side. Inserts should be located at least 0.040 in. from corners. Although square corners can be molded, good design dictates a minimum radius of 1/64 in. where possible.

Glass-mica can be machined readily with carbide-tipped tools, and can be ground to a high finish.

How Section Size Affects Gray Iron Castings

These graphs compare strength, hardness and microstructure. To get desirable combinations of machinability and strength, consider microstructure and strength requirements simultaneously.

by R. C. Bates, *Materials Engineering Dept., Westinghouse Electric Corp.*

■ All known foundry experience indicates that large variations in the mechanical properties of gray iron castings are experienced in different section thicknesses of the same casting. Nonetheless, tensile strength of cast iron is usually determined by testing separately cast arbitration bars of standard size and design rather than test specimens from actual castings. The mechanical properties of 1.2-in. dia arbitration bars specified by ASTM A48 are as follows:

ASTM A48 Class No.	Ten Str, psi	Bhn, max
20	20,000	230
30	30,000	250
40	40,000	270
50	50,000	290

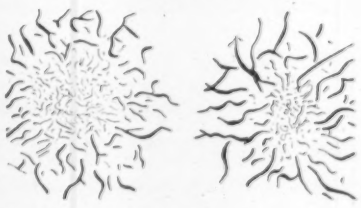
Previous work indicated that the tensile strength of Class 30 castings varied from 46,200 psi in 0.5-in. dia bars to 29,800 psi in 2-in. bars. Such variation could lead to either lower strength or greater machining difficulties than anticipated by designers and engineers unless information was obtained concerning the variations to expect in hardness, strength and structure in various section sizes of each class of gray cast iron.

Effects on mechanical properties

Based on the tests performed, it is apparent that the tensile strength and hardness of gray cast iron arbitration bars decrease as section size increases. The rate of decrease is high in small bars but tends to level off in bars 1.5 to 2 in. in dia. Fig 2-7 show the effects of section size on the mechanical properties of the different classes of gray iron specified by ASTM A48.

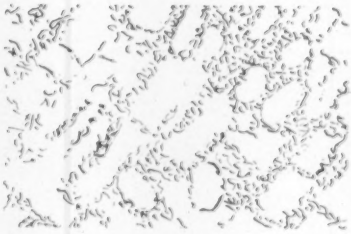
The curves relating tensile strength and section size are all similar in shape but vary in the

Type A
Uniform distribution, random orientation.

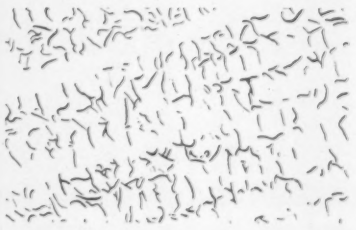


Type B
Rosette groupings, random orientation.

Type C
Superimposed flake sizes, random orientation.



Type D
Inter-dendritic segregation, random orientation.



Type E
Inter-dendritic segregation, preferred orientation.

Graphite Flake Size

Size No.	Length of Longest Flake at 100 dia, in.
1	4 or more
2	2-4
3	1-2
4	1/2-1
5	1/4-1/2
6	1/8-1/4
7	1/16-1/8
8	1/16 or less

Fig 1—AFA-ASTM graphite flake classification in gray cast iron.

Relationship of microstructure, tensile strength, hardness and diameter of gray cast iron specified by ASTM A48

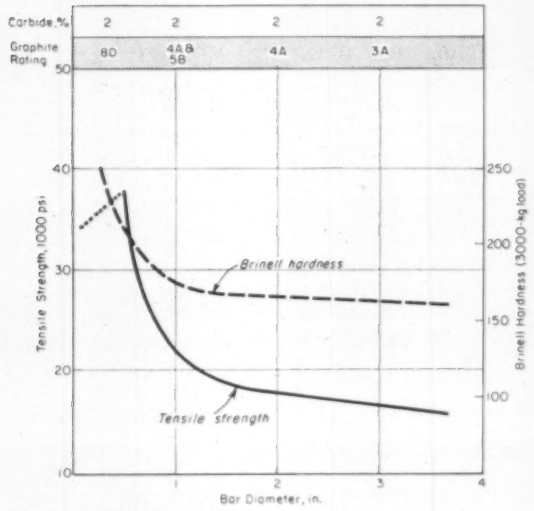


Fig 2—CLASS 20

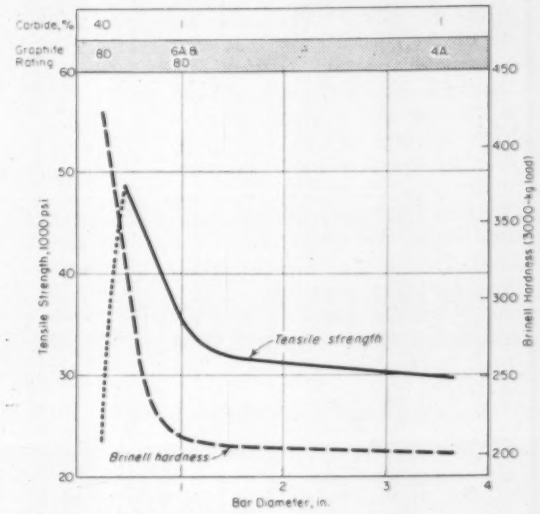


Fig 3—CLASS 30

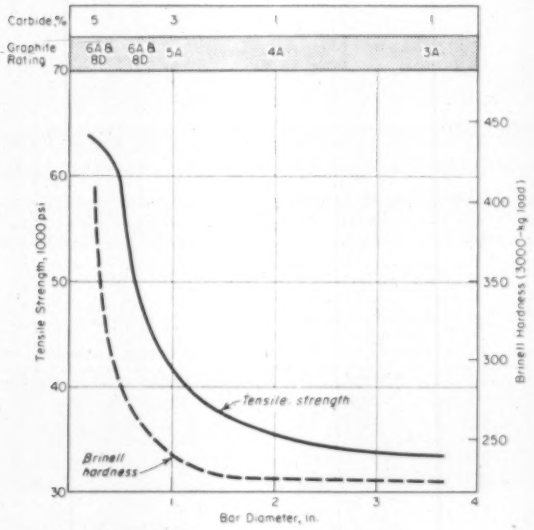


Fig 4—CLASS 40

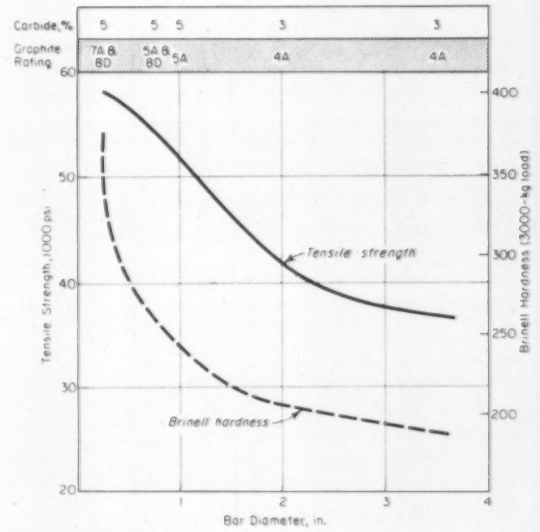


Fig 5—CLASS 40

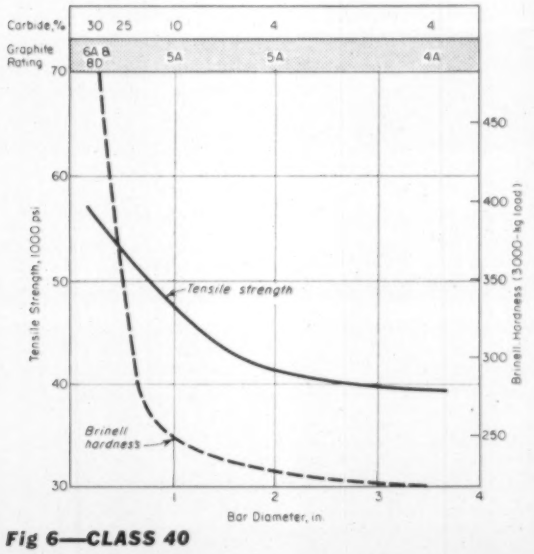


Fig 6—CLASS 40

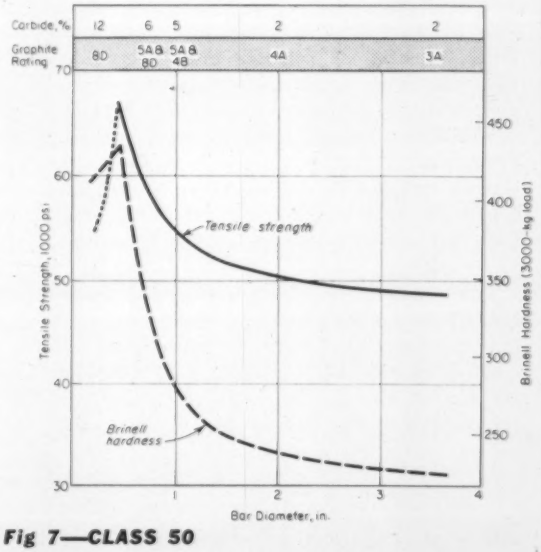


Fig 7—CLASS 50

magnitude of the curve ordinates. All of the curves show that only a small change in strength and hardness results from a change in the size of the larger diameter bars. In bars less than 1 in. in dia, however, a small decrease in diameter significantly increases the tensile strength and hardness. One exception: the 1/4-in. dia bars. The decrease in strength of the small bar is probably associated with the presence of large amounts of free carbide and/or fine type D graphite in the microstructure.

Fig 1 shows the standard ASTM graphite types.

Microstructure and machinability

Hardness is a significant factor in the machinability of cast iron and may frequently be used as a machinability index. In milling gray cast iron, for example, tool life nearly doubles as the microstructure is varied from 100% fine pearlite to a mixture of ferrite and coarse pearlite. Tool life is proportional to the decrease in hardness accompanying such a change in microstructure. The recommended machining rate for acicular cast iron is approximately one-half of the rate recommended for pearlitic cast iron. The machining rates recommended for martensitic structures are even lower. These decreases in machining rates are proportional to the increase in hardness which accompanies the change in microstructure.

Don't judge machinability by hardness. Hardness is *not* a suitable machinability index of ferritic, pearlitic, or acicular gray cast iron, however, if more than approximately 3% massive carbide is present in the microstructure. If extensive machining is required, section sizes that will contain more than 5% massive carbide in the microstructure should be avoided.

For example, the hardness of the 1.2-in. dia bars in Fig 4 and 5 is 240-250 Bhn. Comparing the amount of carbide, as shown at the top of the graphs, however, indicates that the bar in Fig 5 contains 10% massive carbide compared to only 4% for the bar shown in Fig 4. This additional carbide may cause excessive tool wear.

In milling, tool life is not seriously reduced at low speeds (less than 200 fpm) unless the microstructure contains 15 to 20% massive carbide. At high speeds, however, carbide over 5% shows up as "hard spots" and causes excessive heating of the tool and drastic reduction of tool life. Thus, hardness alone cannot be considered a suitable machinability index for cast iron containing more than 5% free carbide.

Control carbides. Carbide content can be controlled since, in the range of compositions studied, section size (and, indirectly, cooling rate) rather than composition controls the graphite type and size. Fine type A and/or type D graphite were found in thin sections, while coarse type A was found in heavy sections.

A further control of carbide content can be obtained by composition variations. The carbide content is increased by adding chromium or by lowering the carbon equivalent (% C + 1/3[% Si + % P]), and it is decreased by adding copper or nickel.

Materials and Test Procedure

The composition of gray cast iron is not usually specified. However, foundries usually work to definite composition limits to insure that the specified mechanical properties are consistently obtained. The composition limits of the cast irons in this study are given in the table below.

Six sizes of arbitration bars ranging from ¼ to 3½-in. dia were poured. In all, bars from 42 heats were tested. Tensile specimens were machined from the lower halves of the arbitration bars according to the requirements of ASTM A48 (the ¼-in. dia bars, however, are not covered by the specification). The ¼-in. bars were ground to provide a 1-in. long by 3/16-in. dia gage section with ¼-in. dia unthreaded gripping ends. The specimens were only tested for ultimate strength since gray cast iron does not usually exhibit sufficient ductility to permit accurate measurement of yield strength.

A flat surface was made on a portion of each of the three larger bars (1.2 in. dia and larger) by grinding to a depth of ¼ in. below the surface so that three Brinell hardness measurements could be made on each. A ½-in. slice was cut from each of the smaller bars with parallel saw cuts and three Rockwell C measurements were made on each piece at approximately mid-radius. The Rockwell C numbers were converted to Brinell hardness numbers to place all hardness data on the same scale. The average of each set of three readings was calculated and tabulated.

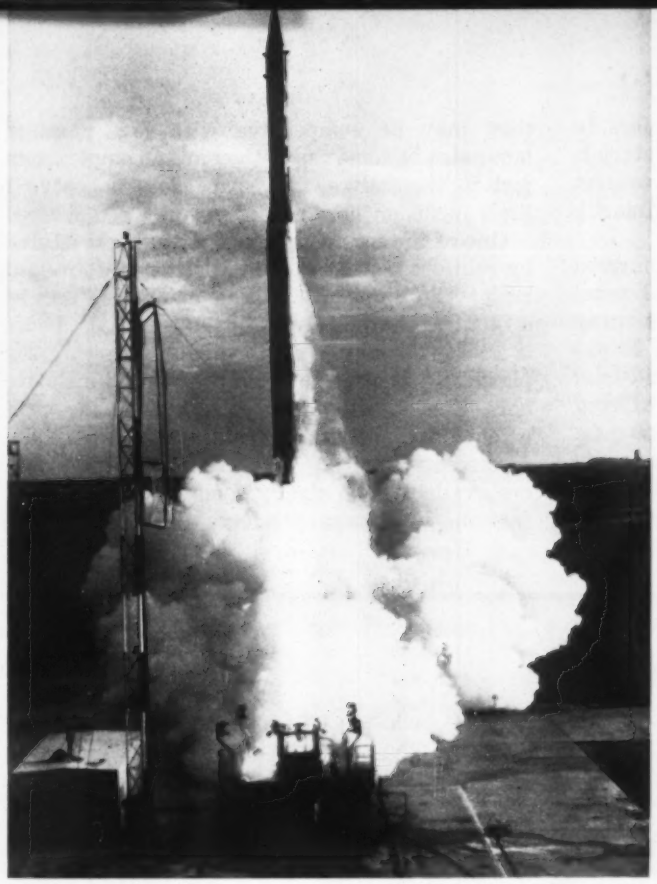
A ½-in. thick slice was cut from the midlength of each bar and used for metallographic examination of the surface and center of each bar. Graphite was rated for type and size in accordance with ASTM Spec A247 (see Fig 1).

AVERAGE COMPOSITION OF GRAY CAST IRONS TESTED (%)

ASTM A48 Class No.	C	Si	Mn	S	P	Cu	Ni	Mo	Cr
20	3.41	2.23	0.65	0.12[a]	0.21	—	—	—	—
30	3.19	1.54	0.65	0.11	0.10	—	—	—	—
40	3.24	1.56	0.61	0.09	0.12	1.61	0.68	—	—
40	3.20	1.64	0.62	0.10[a]	0.10	—	0.65	0.47	—
40	3.20	1.92	0.65	0.09	0.10	—	—	—	0.88
50	3.20	1.64	0.58	0.10	0.10	—	2.28	0.92	—

[a]Estimated.

M/DE Manual No. 167
February, 1960



Military *uses include nose cone for this Vanguard test vehicle.*
Martin Co.

Low Pressure Reinforced Plastics

by **Malcolm W. Riley**, *Associate Editor, Materials in Design Engineering*

Commercial *uses include the hull of this 40-ft sailboat of the Block Island Class.* Owens-Corning Fiberglas Corp.

High strength-to-weight ratio plus the ability to be easily formed into complex curvatures —these are among the most important reasons for the extensive use of low pressure reinforced plastics in structural applications. Here is an up-to-date rundown on

- *Resins and reinforcements*
- *Molding methods*
- *Design information available*

Structural reinforced plastics here refers to low pressure reinforced plastics—those materials which can be formed at relatively low pressures (less than 1000 psi), and which are primarily structural in function.

Such scope includes reinforced plastics formed by contact, bag, preform, centrifugal, and matched die molding methods, as well as spray molded and filament wound structures. It excludes high pressure laminates (industrial thermosetting laminates), and fiber-reinforced compression and transfer molding compounds. (Premix molding compounds are essentially reinforced polyester compression molding compounds. Although from the design standpoint they may be competitive with low pressure laminates in some cases, they are a complex subject in themselves, and space does not permit their inclusion here.)

One of the most important advantages offered by reinforced plastics is high strength-to-weight ratio. The emphasis in this manual is on the structural characteristics of the materials. There is a large amount of data available on reinforced plastics—too large to attempt to be all-inclusive here. The objective here is to outline the most recent developments in resin systems and reinforcements, indicate what reliable design data are available, and clarify some of the confusing factors that make reinforced plastics unique.

Materials and methods

Essentially reinforced plastics consist of:

1. *A resin system,* which may include in addition to the resin itself, modifiers (such as monomers, flexibilizers, and promoters), hardeners or catalysts, fillers, and pigments. The resin system for the most part, determines basic chemical and moisture resistance, thermal stability, electrical properties, weatherability, thermal insulating characteristics, color, and to a degree, type of surface finish.

2. *Fibrous reinforcements* which, for the most part, determine mechanical strength and bulk. With a low fiber content, the fibers essentially reinforce the resin in a manner analogous to that of steel reinforcement in concrete. With a high fiber content, the resin actually acts as an adhesive, binding together the mass of fibers.

Consequently, in designing with the materials, such factors as type of resin, type and form of reinforcement, proportion of resin to reinforcement, type of forming method, and curing conditions must all be considered—and, in addition to these, the result of interactions between these variables.

The resins

Four basic families of resins are used for low pressure reinforced plastics. The following sections describe each briefly, and indicate the most recent developments in terms of newer or improved resins.

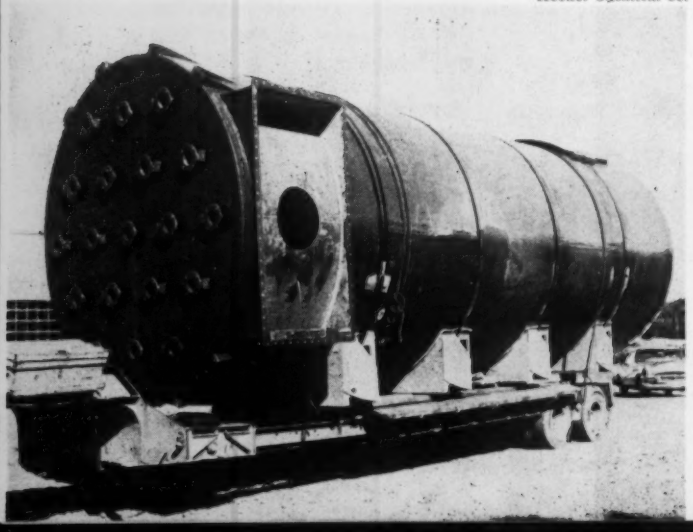
Polyesters

By far the largest and most widely used family of resins for reinforced plastics, polyesters of-

COMMERCIAL APPLICATIONS INCLUDE . . .

Scrubber tanks *such as this 33-ft long one made of fire resistant polyester by Du Verre, Inc. Replacing lead-lined stainless steel, the tank is lighter in weight and is expected to have a longer service life.*

Hooker Chemical Co.



Truck cabs *such as this White "5000" cab. Matched-metal-molded in glass-polyester the cab is lighter in weight, made with fewer parts at lower tooling costs, and provides better thermal insulation than metal cabs.*

Molded Fiber Glass Body Co.

fer low cost (32-40¢ per lb), excellent processing characteristics, good balance of physical and mechanical properties, and the ability to be cured at room temperature if necessary. Most parts commonly, but erroneously, called "fiberglass" are glass-reinforced polyester resin.

General purpose types (containing monomeric styrene, diallyl phthalate, or vinyltoluene as crosslinking agents) are available in a variety of types tailored to provide the best handling characteristics for specific molding methods. They are available in the form of rigid, resilient, or flexible materials to provide a range of rigidity and impact strength. Heat resistance of general purpose types is usually limited to about 160-200 F. Self-extinguishing grades are available. Common uses are boats, chairs, luggage, tote boxes, housings, etc.

TAC-polyesters (those containing monomeric triallyl cyanurate as a crosslinking agent) are designed for high temperature use (i.e., 500 F temperature range). Mostly used in the form of prepregs (reinforcement impregnated with resin, partially cured to a B-stage, and supplied to fabricator who lays up to the finished shape and completes the cure with heat), TAC-polyesters had initial handling problems which have to some extent been overcome by more recent resin developments. Primary uses are high temperature structural parts for high speed aircraft, e.g., radomes and hot air ducts.

Isophthalic polyesters (made by reacting isophthalic acid rather than other dibasic acids such as phthalic anhydride, with a glycol and adding a monomeric crosslinking agent, such as styrene) are relatively new, and are reported to have substantially improved wet strength, flexural strength and reverse impact strength. Data are as yet limited and apparently contradictory. Reported reproducibility problems in production of the raw material make it difficult to reliably state benefits of the resin quantitatively. Such resins are available from several polyester producers. An isophthalic polyester is now being used for the Corvette body.

Epoxies

Use of epoxies for reinforced plastics has been limited to critical applications where the materials' excellent mechanical strengths, extremely low moisture absorption, excellent electrical properties and chemical stability are required. Primary limiting factors have been high materials cost (about 65¢ per lb) and the need for carefully controlled cure to obtain maximum properties. The epoxies do have good processing characteristics, however, and can be cured at room temperature for uses where maximum physicals are not necessary.

Processability and properties of a reinforced epoxy material are highly dependent on the type of hardener used to cure it. Aliphatic amines provide optimum handling characteristics; aromatic amines provide good short-time heat resistance; anhydrides generally provide improved heat resistance; vegetable oil polyamides provide greater flexibility; catalytic hardeners can be used to alter handling characteristics, such as shelf life.

General purpose epoxies (reaction product of epichlorohydrin and bisphenol A) are limited in heat resistance to about 200-350 F, depending on resin, hardener and cure. They are used primarily for applications such as filament-wound pressure vessels, high strength aircraft structure, reinforced chemical piping, and plastics tooling (e.g., reinforced epoxy dies for drawing sheet metal).

Most development work in epoxies has been aimed at boosting heat resistance, improving curing characteristics, and lowering cost. Epoxy-phenolic resin blends have provided some improvements in heat resistance. The most promising recent develop-

Chemical tanks, *where chemical resistance is critical. Tanks such as this glass-polyester one made by Metal Cladding, Inc., are light in weight and provide good thermal insulation.*

Hooker Chemical Co.

Aircraft luggage pod *for Boeing 707, made by Molded Fiber Glass Co. Made of glass-reinforced fire resistant polyester, the pod is lightweight, tough, and requires little maintenance.*

Hooker Chemical Co.

ments have been the peracetic diepoxides, on which data are quite limited, and newer epoxy novolacs (reaction product of epichlorohydrin and a novolac resin). Both resin systems appear to offer good 500 F strength retention. Further details are given in the section on "Resistance to Heat and Cold."

Phenolics

In low pressure laminates, phenolics are used almost solely for heat resistance applications. They are usually fabricated from prepregs. Problems have centered around obtaining a good resin-glass bond at low pressures, and removing the moisture produced by the condensation reaction by which phenolics cure.

High temperature phenolics and the newer phenyl silane resins provide long-time heat resistance in the 500-600 F temperature range and short-time (several minutes) heat resistance up to 1000 F. Much work has been done in reinforcing phenolics with asbestos felts and mats for high temperature resistance.

The successful (and much publicized) use of reinforced phenolics for ablative reentry nose cones and missile hardware operating in the temperature range of 3000-25,000 F is dependent on extremely short periods of exposure. Many of these parts are formed by high pressure molding techniques.

Silicones

Low pressure reinforced silicone laminates are limited to applications where heat resistance, usually in combination with excellent electrical properties, is required. Although mechanical strengths are relatively low, a high percentage of initial strength and electrical properties is retained after long-time exposure to moisture or to temperatures in the 500 F range. Silicone resins are relatively costly ($1.55-1.70 per lb at 60% solids content) and handling characteristics have been problematic. Most fabrication has been from prepreg.

Newer resins are available with improved handling characteristics. Also, a solventless silicone resin now permits satisfactory fabrication using wet layup techniques.

Acrylic syrup

A polymethyl methacrylate syrup is available for use in low pressure reinforced plastics, primarily in applications where weather resistance is critical. It provides weather resistance superior to that of polyester and polyester-methyl methacrylate combination resins. Mechanical strengths are moderate, but weather resistance and light transmission are excellent.

The reinforcements

Fibrous glass is by far the most widely used reinforcement in low pressure laminates; consequently most of this article deals with glass-reinforced laminates. Other types are used for relatively specialized applications.

Asbestos felts and papers are used in conjunction with phenolic resins for some high temperature applications. Most of the uses for synthetic fibers—nylon, Orlon, Dacron, Dynel—have been as a reinforcement in molding compounds and high pressure laminates. These fibers are used to a limited extent in low pressure laminates where improved impact strength, abrasion resistance, chemical resistance, or a particular surface effect is desired.

Recently developed graphite textiles appear promising, particularly in laminates for high temperature use. Initial evaluations are being carried out on high pressure laminates. The textiles are produced by a special graphitizing process in which organic fibers in the finished textile form are converted to graphite.

Relatively little work has been done evaluating metal fibers or wires as reinforcement for low pressure laminates. Some studies are now being made of filament-wound piano wire structures; studies are also being made on impregnating a compacted and sintered metal fiber matrix with resin.

But glass is still the most widely used and accepted reinforcing fiber for low pressure laminates. The most common fiber is E glass (a lime-alumina borosilicate), though other types are used for specialty applications, e.g., 96% silica and quartz fibers for extreme high temperature applications.

Textile forms

The textile form of the reinforcement has a critical effect on load bearing ability of reinforced plastics. Briefly, common types of glass reinforcements are:

1. Cloth and mat — Cloth and mat are two of the most widely used forms of glass reinforcements. Cloth reinforcements provide maximum strengths, but strengths are orthotropic. Mats provide lower strength levels, but strength is isotropic.

2. Rovings — Untwisted rope-like bundles of continuous glass strands, rovings are widely used, both unwoven for unidirectional strength characteristics, and woven into heavy, coarse fabrics for bidirectional strength.

3. Chopped fiber—Both chopped strands and rovings are used in preform molding and spray molding. Molding by either technique can provide moldings with properties similar to those of mat-reinforced laminates.

Glass finishes

No matter in what form the glass is used, the finish applied to the glass after removal of the sizing (sizing is used to protect and lubricate the glass filaments during their production) is critical in obtaining desired end properties. With silicone resins, optimum bond is obtained when the resin is applied to a heat-cleaned glass fiber surface, but for all other resins some type of finish must be specified to obtain optimum glass-resin bond.

Selecting the proper finish is still an art. Actually, the mechanism by which the finish affects the glass-resin bond is not clearly understood. Somehow to gain optimum strengths the finish must provide good interlaminar resin-

TABLE 1—COMPARISON OF MOLDING METHODS

Molding Process ↓	Economic and Design Factors (qualitative comparison)[a]							Maximum Allowable Glass Content, % by wt[b]			
	Equipment Cost	Rate of Production	Molded Part Strength	Importance of Operator Skill	Part Complexity Possible	Part Reproducibility	Reinforcement Most Often Used	Mats	Fabrics	Rovings	Woven Rovings
Contact	1	1	3	10	10	1	Woven roving	30	50	50	45
Vacuum Bag	2	2	4	9	9	3	Fabric	35	55	60	50
Pressure Bag	3	3	6	6	7	4	Mat	35	55	60	50
Spray	4	4	1	10	10	1	Chopped roving	X	X	35[c]	X
Autoclave	5	5	8	8	8	7	Fabric	50	65	75	65
Filament Winding	6	6	10	2	4	9	Roving	X	X	90	X
Continuous Extrusion	7	9	9	1	2	9	Roving	X	X	55	X
Matched Die	8	8	7	4	5	8	Mat	45	60	70	60
Centrifugal	9	7	8	3	3	6	Mat	35	55	X	50
Continuous Laminating	10	10	5	2	1	10	Fabric	X	50	50	X

[a]10 = highest; 1 = lowest. [b]X = Not applicable. [c]Chopped roving. Source: Owens Corning Fiberglas Corp.

glass bonding. But whether the effect of the finish is 1) to provide a molecular link between the glass and resin by primary chemical bonds, or 2) to act as a deformable layer capable of relaxing shear stresses at the glass-resin interface, or 3) to increase coefficients of friction between the resin and glass surface, or 4) to provide a combination effect of these three—the answer is still in the realm of the theoretical.

From the practical standpoint, finish selection should be made on the basis of materials suppliers' recommendations. Experience has provided data indicating which finish to use with each resin. Two basic finishes have provided optimum bonds and thus are widely used. They are:

1. Chrome finishes—Volan A (a methacrylate chromic chloride complex, neutralized with ammonia) is one of the most widely used finishes with polyester and epoxy resins. It provides reasonably good bonds also with phenolics. It is chemically similar to the older finish 114.

2. Silane finishes—A variety of silane finishes are used, primarily for improved wet strength. NOL 24 (reaction product of allyltrichlorosilane and resorcinol) can be used as a universal finish to provide good general bonding with polyesters, epoxies, phenolics and silicones. A-1100, an amino silane (hydrolysis product of ∂-aminopropyltriethoxysilane) provides excellent bonds with epoxy and phenolic resins. Several other finishes are specifically recommended for use with polyesters, e.g., Garan, A-172, 136, and 301.

The processes

Table 1 compares the low pressure molding processes commonly used. The table rates them qualitatively in economic and design factors and gives maximum allowable glass contents. Contact, bag and autoclave molding are similar in procedure, but differ in pressures used and in the ways pressure is obtained. In each of these processes, wet or dry layup techniques may be used. In wet techniques, liquid resin is brushed into the layers of glass cloth or mat; in dry layup, prepreg materials are used. All the resins are suitable for molding by these techniques.

Contact moldings are cured with no pressure; *bag* molding makes use of a polyvinyl alcohol "bag" or film to enclose the laid-up part. Then either a vacuum is drawn within the bag, developing effective pressures on the laminate of about 10-14 psi, or compressed air or steam is applied outside the bag to develop effective pressures of about 40 psi on the laminate.

Autoclave molding, as implied from the name, makes use of steam pressures of up to about 100 psi to cure the laminate in an autoclave.

In *matched die* molding, the reinforcement—usually mat or a preform (prepregs can also be used)—is positioned in the mold, a premeasured quantity of resin is poured in, and the mold is closed and heated. Pressures used generally vary between 150 and 400 psi. Equipment costs are relatively high, but quality and reproducibility are also high.

In *filament winding*, glass filaments, usually in the form of rovings are saturated with resin and wound by mechanized techniques onto mandrels the shape of the finished part. Although wet techniques (i.e., roving is run through a liquid resin bath and onto the mandrel) were first used, the trend is toward wider use of preimpregnated rovings. The dry technique minimizes resin waste, and slippage of the fibers on the mandrel. The technique provides a mechanized method of precisely orienting reinforcing filaments in the desired direction.

Since the purpose in filament winding is usually to obtain maximum strengths, epoxy resins are most widely used. Problems have been encountered with silicone resins; it is difficult to completely remove the sizing from individual strands of the roving prior to impregnating with the silicone resin. Developmental work is under way to solve this problem.

Spray molding is a process by which resin systems and chopped fibers are sprayed simultaneously

from two guns against a mold. First developed for polyester resins, guns are now available for spraying epoxy. The mixture is manually sprayed against a mold and rolled flat with a hand roller. Control of wall thickness is aided by use of color-coded fibers to provide visual indication of relative concentration of material over the mold area.

The technique is relatively low in cost, production rate is relatively high, and relatively complex shapes can be made. But the process is highly dependent on operator's skill. When applied by a skillful worker, structures have properties somewhat comparable to those of mat-reinforced laminates.

In addition to these techniques, a variety of other low pressure laminating methods are used. These include continuous laminating, in which flat or corrugated sheet is produced on a continuous basis with maximum reproducibility; continuous extrusion, by which rod stock is produced in a similar fashion; and centrifugal casting, in which a tubular mold is lined with a reinforcing mat or cloth, liquid resin is inserted, and the mold centrifuged, forcing the resin into the reinforcing material.

Designing: state of an art

The problem in designing with reinforced plastics lies in the variability of the material. The design theories and applicable structural design equations are available (see *Sonneborn, Dietz, Marine Design Manual,* etc.). The problem is: What strength values should be substituted in the equations? And once given a value, how heavily can the engineer rely on it being produced in a given laminate under commercial production conditions?

The reliance that can be placed on a given property from part to part is directly proportionate to the degree of informed control exercised over the variables that affect end properties. These variables exist in all phases of materials production and fabrication—all the way from the production of the resin and reinforcement to the final cure of the part.

The design engineer working with conventional engineering materials usually employs a limited number of materials of specifiable standard minimum properties; he does not normally get involved in the composition of the material itself. At present there are very few standards in low pressure reinforced plastics, consequently the engineer must consider all the factors which will affect the quality of the laminate.

Variables that can be controlled by the design engineer include 1) choice of type, form and proportion of reinforcement, 2) resin, 3) form and dimension of the part. and 4) molding method to be used. Factors that cannot be controlled by the design engineer include variability of resins and the components used in their formulation, and variations in workmanship and technique.

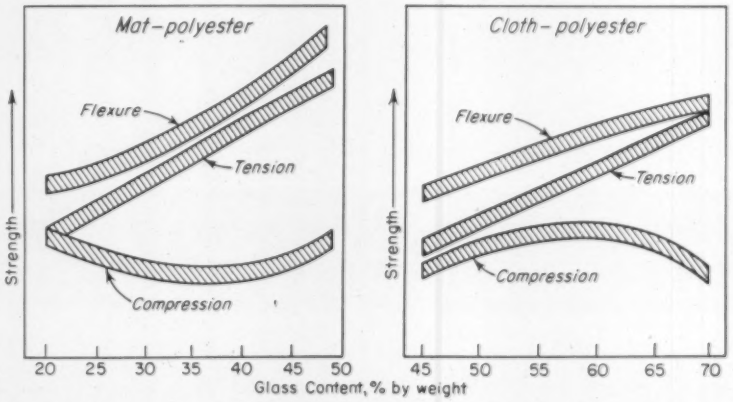
Effects of variables on properties

An extensive study of the control of variables in heat resistant glass reinforced plastics was carried out by Owens-Corning Fiberglas Corp. under Air Force contract. The resulting 577-page report provides an excellent insight into the complexity of the materials. For example, in the study of one specific fabric-reinforced laminate, 608 instances of a process variable affecting a property were found. Of these, 207 involved the interactions of two variables.

Obviously some variables exert a greater influence than others. Following are some of the more important variables, and a discussion of the way in which they usually influence properties.

1. Effect of glass content—Proportion of glass is important. In general, for cloth-reinforced laminates highest glass contents provide optimum tensile properties; lowest glass contents provide optimum compressive properties; and a compromise in content provides optimum flexural properties. The relationship differs somewhat with mat. Fig 1 shows these effects qualitatively. Structural laminates usually have 20-60% glass content, by weight.

In considering the glass content, the molding method and type of reinforcement must also be considered. The method of molding has a definite effect on the permissible glass content, as shown in Table 1. Maximum glass con-



1—*Qualitative effects of glass content on strengths of mat and cloth reinforced polyester laminates.* (Sonneborn)

tent, of course, is obtainable in filament-wound structures, where the resin actually acts as an adhesive holding the filaments in place. Minimum glass contents occur in contact molded laminates, where minimum pressures are used.

2. Effect of laminate thickness —The density and thickness of a laminate depend primarily on type of reinforcement, molding method and molding technique. In general, as molding pressure increases, laminate thickness decreases, and glass content and density increase.

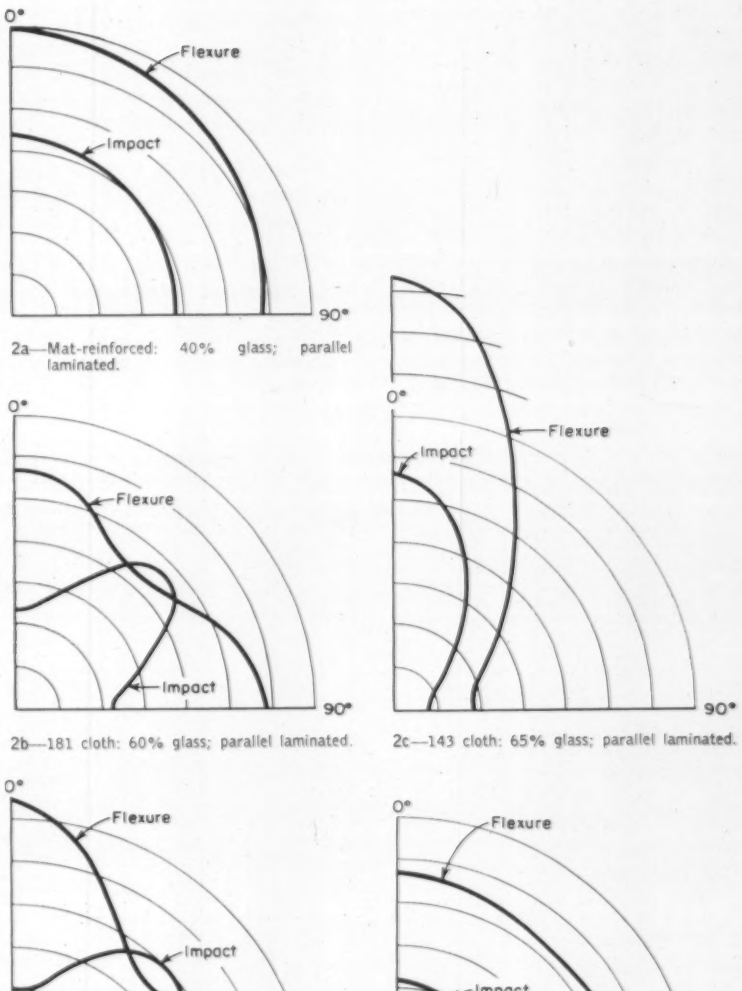
For a given laminate, however, no true correlation has been developed to indicate the effect of changing thickness on properties. Data on thin laminates vary considerably among different sources. Some tests indicate increasing strengths with decreasing thicknesses; others indicate decreasing strengths with decreasing thicknesses. Evidently the effects are due to some characteristic of the material that is not yet understood.

3. Orientation of glass filaments —Directionality of reinforcement is critical in determining strength of a laminate. Strength follows the direction of the reinforcement.

Stresses acting on a part in service are rarely unidirectional. Consequently, strength values derived from testing in only one direction on a laminate (usually in the warp direction) are rarely sufficient to develop a realistic design. Strength of the laminate in various directons other than the warp direction must usually be known to design a stressed part effectively.

Fig 2 shows qualitatively the directional properties of a mat, and four fabric-reinforced polyester laminates. The concentric arcs represent different impact and flexural strength levels, strengths increasing with distance from the origin. The degrees are degrees from warp direction, "0 deg" being parallel with warp. The opposite three quadrants not shown will display the same strength patterns.

Fig 2a shows mat-reinforced laminates to be relatively isotropic. The 181 fabric (satin weave) shown in Fig 2b is bidirectional, having lower values for flexural strength and higher values for impact at 45 deg to the warp direction. Fig 2c shows the directional characteristics provided by the 143 fabric which has about 90% of its yarns in the warp direction. Fig 2d and 2e show different strength configurations obtainable by alternately orienting different plies in slightly different directions.



2a—Mat-reinforced: 40% glass; parallel laminated.

2b—181 cloth: 60% glass; parallel laminated.

2c—143 cloth: 65% glass; parallel laminated.

2d—143 cloth: 65% glass; plied at 0 and 90 deg.

2e—143 cloth: 65% glass; plied at 0, 45, 90 and 135 deg.

2—*Effect of fiber orientation on flexural and impact strengths of glass reinforced laminates. Equations are available for determining specific values at any given degree from warp, given zero and 90 deg values.* (Sonneborn)

Safety factor in design

Safety factor is the ratio of the ultimate strength of the material to the allowable working stress. Because of the lack of standard strength values for reinforced plastics, it is a difficult value to determine.

When not specified by codes, the safety factor to be used in reinforced plastics should be based on 1) accuracy of the estimated load on the structure; a precise load value permits a lower safety factor, 2) degree of precision possible in analysis and determination of stresses, 3) degree of homogeneity and uniformity provided by fabrication techniques used, e.g., press-molded laminates will have greater homogeneity and uniformity than contact molded, 4) nature of load; i.e., certain types of loads, such as long-time, impact loading, and reversing stresses, reduce the allowable design strength of the material, and 5) service requirement, i.e., where failure can cause personal injury or damage to expensive equipment, larger factors should be used.

Mechanical strength (short term)

Because of the variability of materials, a good design practice is to use minimum design values for which materials have qualified in accordance with the various military specifications. Substantially higher values are obtainable in certain constructions and under carefully controlled conditions. But the effects of variables are such that the use of specification minimum values in preliminary design analysis is generally recommended.

Minimum design values

Table 2 shows *reduced* mechanical properties of polyester, phenolic and epoxy low pressure laminates with different reinforcing fabrics and mat. These values are generally allowable for design with

TABLE 2—REDUCED MECHANICAL PROPERTIES OF LOW PRESSURE LAMINATES[a]

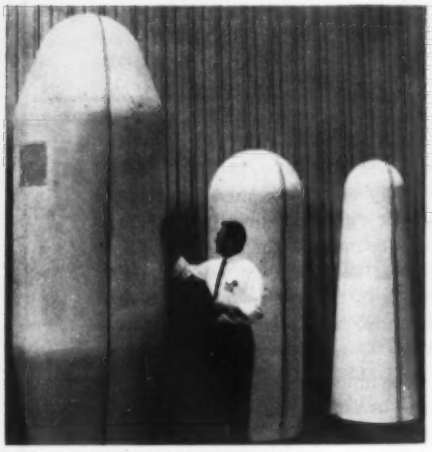
	Resin →	Polyester (MIL-R-7575); Phenolic (MIL-P-25515, MIL-R-9299)						Epoxy (MIL-R-9300)			
	Fabric →	181	112	128	143	120	Mat	181	112	143	120
	Angle of Load, deg										
TENSILE PROPERTIES											
Ult Str, 1000 psi	0	38	38	38	75	38	18	45	45	85	45
	90	35.1	34.4	29.2	8.95	35.7	18	42.4	40	10.2	43.7
	45	17.8	18.3	17.2	11.7	17.9	18	26.6	21.7	12.7	22.8
Stress at Prop Limit, 1000 psi[b]											
Initial	0	5.45	10.5	4.9	—	9.5	2.8	11.1	13.2	30.7	15.4
	90	5.2	8.7	4.75	2.2	5.0	2.8	9.6	14	4.6	15.2
Secondary	0	22.6	26.2	29.1	51.5	28.6	8.1	23.7	36.5	58.1	42.9
	90	19.4	24.1	24.46	7.1	20.1	8.1	19.9	36.5	6.75	43.2
	45	2.85	3.35	3.94	3.3	2.9	8.1	3.6	3.3	3.25	3.3
Mod of Elast, 10^6 psi[b]											
Initial	0	2.62	2.6	2.82	—	2.88	1.46	3.32	3.13	4.86	3.06
	90	2.49	2.55	2.17	1.6	2.79	1.46	3.21	2.92	2.1	3.01
Secondary	0	2.34	2.31	2.47	5.39	2.56	1.18	2.88	2.3	4.58	2.2
	90	2.15	2.16	1.7	0.42	2.41	1.18	2.66	2.13	1.82	2.17
	45	1.57	1.49	1.41	1.57	1.76	1.18	2.2	1.61	1.78	1.68
COMPRESSIVE PROPERTIES											
Ult Str, 1000 psi	0	30	30	21	45	30	18	45	45	60	45
	90	31.6	26.8	20.9	19	26.1	18	38.2	42.5	26.3	43.6
Str at Prop Limit, 1000 psi	0	19.6	18.9	21	45	30	18	20.6	17.7	27.7	18.4
	90	19.8	17.6	20.9	19	21.1	18	17.9	14.9	6.1	16.9
Mod of Elast, 10^6 psi	0	2.94	2.72	2.9	4.91	2.78	1.61[c]	3.28	3.18	5.12	3.25
	90	2.82	2.54	2.22	1.51	2.71	1.37[d]	3.14	3.1	2.08	2.85
FLEXURAL PROPERTIES											
Mod of Rupture, 1000 psi	0	45	45	39	78	45	22	65	65	110	65
	90	40.9	37.3	33.1	15.1	35.7	22	57	58.4	21.7	62.4
Stress at Prop Limit, 1000 psi	0	27.8	23.9	21.7	69.5	25.4	11.9	38.4	37.1	83.7	35.7
	90	24	20.4	16.5	4.7	19.5	11.9	35.2	30.6	11.4	38.1
Mod of Elast, 10^6 psi	0	2.5	2.5	2.5	4.5	2.5	1.2	3.2	3.2	5	3.2
	90	2.35	2.32	1.94	1.36	2.43	1.2	3.04	3.01	1.93	3.1
SHEAR PROPERTIES (edgewise)											
Ult Str, 1000 psi		9.18	9.46	8.92	7.44	9.23	9.2	14	11.2	7.86	11.8
Stress at Prop Limit, 1000 psi		1.42	1.68	1.45	1.63	1.42	3.1	1.8	1.65	1.63	1.65
Mod of Rigidity, 1000 psi		570	530	510	550	640	610	810	550	590	580

[a]All specimens parallel laminated; see text for derivation of reduced values. [c]Initial. [d]Secondary.
[b]Secondary values show effect of prestressing.

MILITARY USES INCLUDE . . .

Torpedo launching tubes, *such as these centrifugally molded by Apex Reinforced Plastics of glass-polyester. Tubes are lighter, corrosion resistant and have excellent burst strength.* Hooker Chemical Co.

Ground radomes *such as this 55-ft dia glass-polyester one. Made by Universal Moulded Products Co., the radome is fire and weather resistant, permits interference-free radar transmission, and is easily constructed.* Hooker Chemical Co.



Nose fairings *for space probes. These fairings, made of glass cloth-phenolic, protect the payload from air loading and ram friction. They fall away from the missile after it emerges from the earth's atmosphere.* Aerojet-General Corp.

Pressure vessels *made of filament-wound epoxy. Bottles are used in missiles and aircraft, and provide maximum strength-weight ratio.* Aerojet-General Corp.

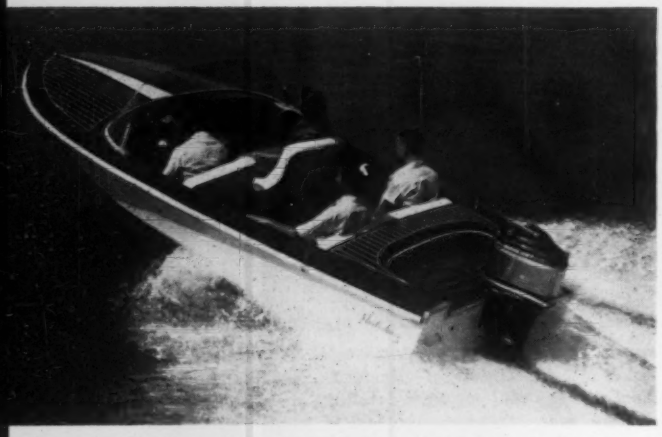
Rocket motor section *spiral-wrapped with asbestos-reinforced phenolic. Low and even ablation accompanied by required strength was reason for use of the material.* Raybestos-Manhattan, Inc.

any resin which is acceptable under the MIL specification given at the head of the table.

Reduced values were obtained as follows: 1) typical strength values obtained by test were reduced to correspond with minimum *wet* values given in the appropriate specification; and 2) since the specifications give no values for directions of loading other than 0 deg to warp, values obtained by test in other directions were reduced by the same proportion as that found between average and specification values for 0 deg to warp. For example, if the specification value for tensile strength is 40,000 psi, and average value from test was found to be 50,000 psi, the value given in the table is 40,000 psi. Also, for the same laminate, average test values for 90-deg tensile strength were multiplied by 0.80 to obtain the reduced values given in the table. Polyesters and phenolics are included in the same column because their reduced values are assumed to be very similar.

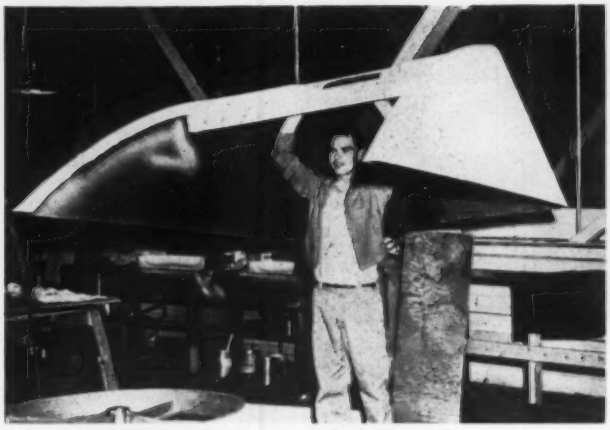
The effects of wet conditioning depend on the resin and the finish used on the reinforcement. Exposures of up to one year in high humidity have reduced flexural strengths 20-30%; however, reduced values were still close to wet-strength specification values. Unpublished data indicate that

MARINE USES INCLUDE . . .



Boats, *which represent one of the largest volume uses for glass-reinforced polyesters. Benefits lie in ease of maintenance, fracture resistance, light weight, and molded-in color.*

Holiday Plastics, Inc.



Boat accessories *such as this fishing bridge for a Richardson cruiser. Made of fire resistant polyester, the bridge can be adapted to a variety of boats.*

Hooker Chemical Co.

such reductions in strength are less in tension and compression than in flexure.

In several instances in the table, initial and secondary tensile values of modulus of elasticity and stress at proportional limit are given. The significance of this dual nature of the linear portions of the stress-strain curves is open to question. However, for designing with polyester laminates, the secondary modulus is recommended since the final modulus is about the same as the secondary modulus. For epoxy laminates, the average of the initial and secondary moduli is recommended. Data on effect of preloading phenolic laminates are not available, but the design moduli are believed to be comparable to those of polyesters.

Remember that the values given in Table 2 are reduced, not typical. Where careful cooperation with materials suppliers is possible, and military specifications are not the deciding factor, higher values can be used for design.

Typical properties

Table 3 shows typical mechanical properties obtainable with polyester, epoxy, and phenolic low pressure laminates. Typical values for a low pressure silicone laminate are also included. Silicones are not commonly used for strength at room temperature, because their mechanical properties are usually substantially lower than those obtainable with the other resins. However, as shown in the subsequent section on heat resistance, in many cases where long-time exposure to temperatures in the 500-600 F range are required, silicone laminates provide higher residual strength after exposure than other laminates.

Filament-wound epoxy structures provide the ultimate in strength. This is due to the control available over the direction of fiber orientation. The highest values reported for filament-wound epoxy unidirectional specimens are tensile strengths of 230,000 psi, flexural strengths of 280,000 psi, compressive strengths of 70,000 psi, and elastic moduli in tension of 7.5×10^6 psi. On bidirectional cylinders, tensile strengths as high as 135,000 psi have been reported.

Such high values should not be used in designing. A more commonly reported value for tensile strength of unidirectionally oriented specimens ("fish-pole stock") is about 140,000 psi. For bidirectionally oriented spherical shapes, tensile values of about 70,000 psi have been used for design. (Such values, of course, must be modified by considerations such as fatigue, long-term loading, and adequate safety factor.)

Maximum strengths are obtainable by making the glass work most effectively, i.e., orienting the glass to provide essentially tensile loading. However, the technique of filament winding is still an art. Recent studies indicate that when testing unidirectionally reinforced specimens in tension by standard methods, failure is actually in shear rather than tension. Work has been done to modify the standard test specimen to obtain failures in pure tension. But even with this modification accomplished, the question remains: Should the allowable design stress be maximum strength of the material in tension or in shear?

In addition to standard forms of glass textiles, two relatively new materials are available to aid in controlling direction of fiber reinforcement. One is the prepreg material called Scotchply, with unidirectional glass reinforcement in

each ply. By altering the direction of each ply within a laminate, unidirectional, orthotropic, or virtually isotropic strength characteristics can be obtained (e.g. see Fig 2d and 2e).

A more recent development is a filament-wound prepreg material, available in both epoxy and silicone. The material is made by filament winding on a mandrel, slitting the wound shape from the mandrel and flattening it, then curing to a B stage. This provides a flat prepreg material with a unidirectional helix angle varying from 30 to 85 deg. Low pressure molded shapes have been produced with flexural strengths as high as 100,000 psi for epoxy and 40,000 psi for silicone.

In more conventional constructions 181 is the most widely used structural fabric. Style 143 fabric, with about 90% of the yarns in the warp direction, generally provides the maximum unidirectional strength. Of course, 90 and 45-deg strengths suffer, as shown in Table 2.

Although mat-reinforced laminates give a substantially lower strength level, strength is isotropic in nature. In many cases, this isotropic characteristic may be more important than the strength level in specific directions.

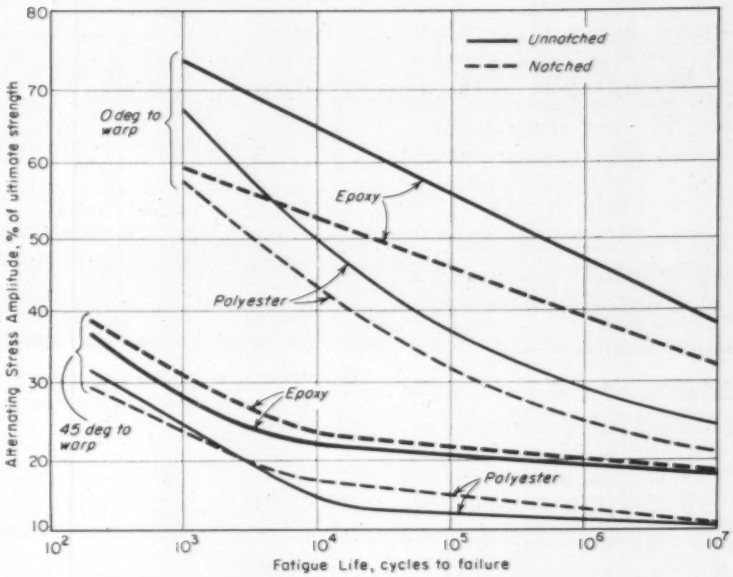
Time-dependent properties

Reinforced plastics are sensitive to duration of loading. The effects vary, and definitive data are not available for all types of laminates. The following discussions indicate the type and general magnitude of the effects of various long-time loading conditions.

Fatigue

Under conditions of cyclic stressing, most metals reach an endurance limit, after which continued stress cycling produces no further reduction in strength. Reinforced plastics do not generally exhibit this behavior.

Fig 3 shows SN curves, plotted as number of cycles to failure vs amplitude of alternating *axial* stress, expressed as a percentage of ultimate tensile stress. Zero mean stress was used, and stress was applied at 900 cycles per min. Curves are given for both notched and unnotched polyester and epoxy resins. In specimens tested parallel to warp out to 10 million cycles, no clear-cut endurance limit is reached. In tests carried out at 45 deg to warp "knees" in the curves indicate that endurance limits may have been reached.



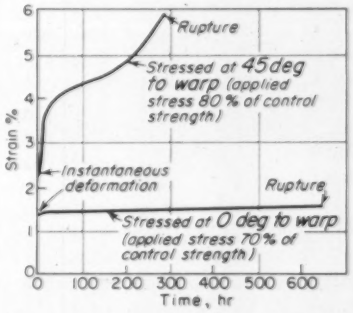
3—*SN curves show epoxy laminates to be superior to polyester in both notched and unnotched conditions.* (Military Handbook 17)

Under conditions of completely reversed alternating stresses, epoxies have higher fatigue strength than polyesters. This is to be expected, since at zero mean stress, tensile and compressive strengths both influence fatigue strength. Compressive strengths of glass-reinforced epoxies are about the same as tensile strengths, whereas compressive strengths of polyesters are usually substantially lower than tensile strengths.

Under axial loading, fatigue strengths at 10 million cycles are only about 20-30% of short-time tensile strengths.

Creep and stress-rupture

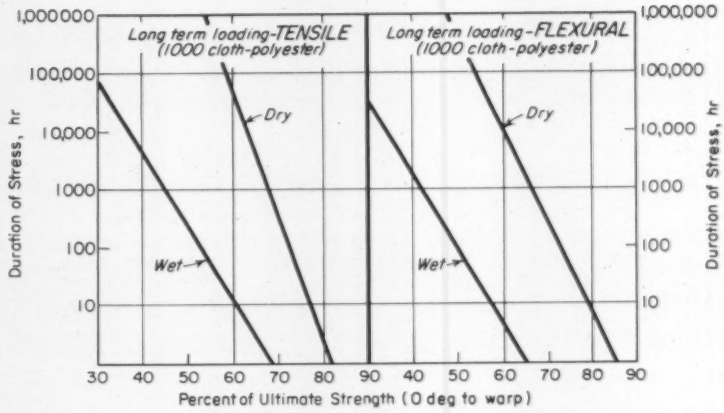
Tensile creep at room temperature of fabric reinforced laminates appears to be negligible—both parallel and perpendicular to warp, although initial deformations are on the order of 0.75-1.75%. Although initial strain for mat-reinforced laminates is much lower than for fabric-base laminates, creep in mat laminates appears to be substantially higher. Tensile loading at 45 deg to warp results in substantial creep. Fig 4 compares creep-rupture curves of a 181 fabric-epoxy laminate when


Rupture
Stressed at 45deg to warp (applied stress 80% of control strength)
Instantaneous deformation
Rupture
Stressed at 0 deg to warp (applied stress 70% of control strength)
Strain %
Time, hr

4—*Creep under tensile loading is substantially higher in the 45 deg-to-warp direction than in the 0 deg direction.* (Military Handbook 17)

loaded at 0 and 45 deg to warp.

Unlike deformation, tensile load-carrying ability of cloth-based laminates is markedly reduced by the length of time under load. This reduction can vary from about 30 to 70% of the short-time ultimate, depending on duration of load. Fig 5 shows this relationship under both wet and dry conditions for a 1000 cloth (plain weave) reinforced polyester laminate under both tensile and flexural loading conditions, expressed as percentage of short-term ultimate vs duration of load.



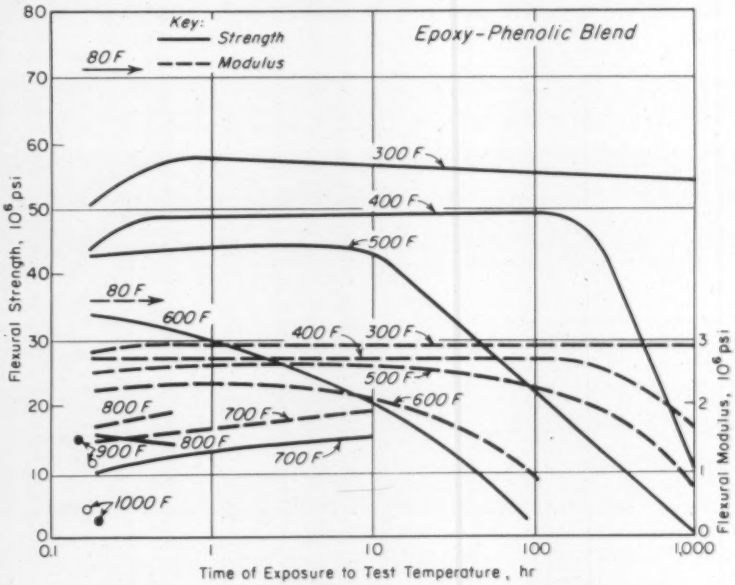
5—*Effect of long-term loading on tensile and flexural strengths of a style 1000 cloth-reinforced polyester laminate, in both the wet and dry conditions.* (Gibbs & Cox)

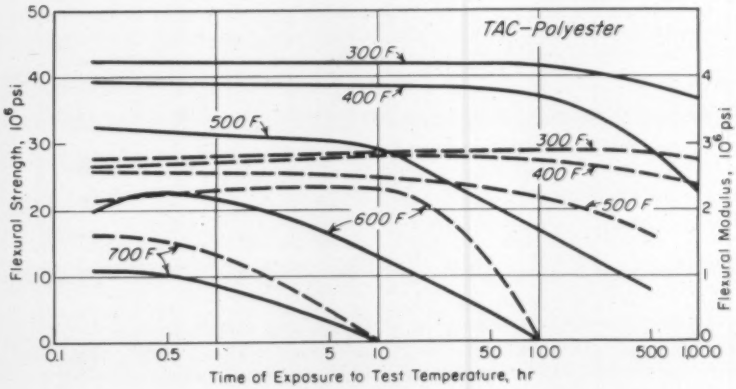
Effects of cold and heat

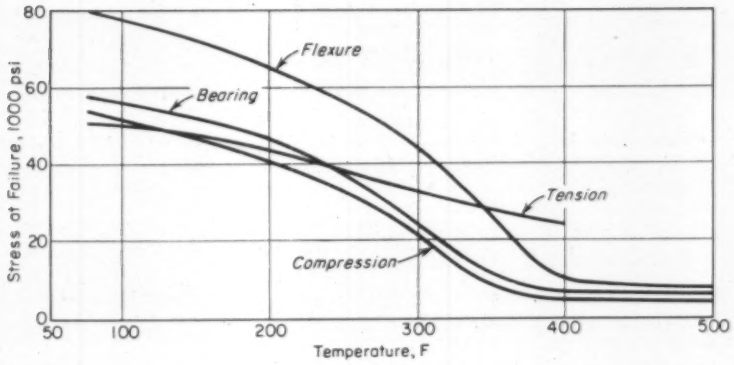
Strength, stiffness, fatigue, and impact properties of glass-reinforced plastics tend to increase with decreasing temperatures, even down to –300 F. Effects of cold differ on laminates reinforced with other types of fibers. For example, impact properties of low pressure phenolic laminates reinforced with cotton fabric decrease with decreasing temperatures.

High temperature uses of reinforced plastics can be divided into two categories: 1) those where the materials are required to retain physical properties under continuous exposure to heat (present limits about 500-600 F), and 2) those short time, higher temperature uses that take advantage of the decomposition time required by the materials; e.g., ablative reentry nose cones (temperature range is about 2000 to 25,000 F). In the first case performance is almost solely dependent on the resin used; in the second case performance (resistance to ablation) is dependent, in a highly complex way, on both resin and reinforcement.

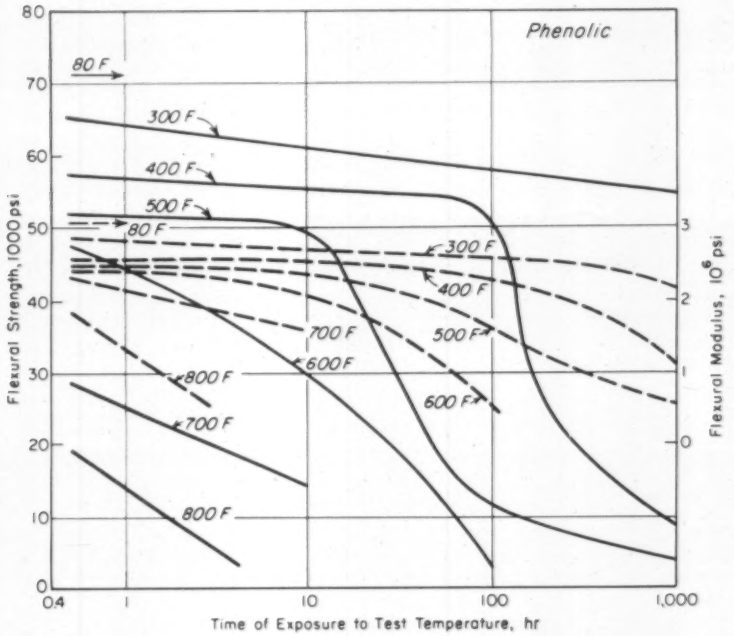
For continuous exposure to heat, phenolics and silicones have long been the best materials—phenolics where structural strength is critical, silicones where electrical properties are critical. With the more recently developed TAC-polyesters, peracetic epoxies, and epoxy-novolacs a wider choice of materials is becoming available for service in the 400-600 F temperature range.

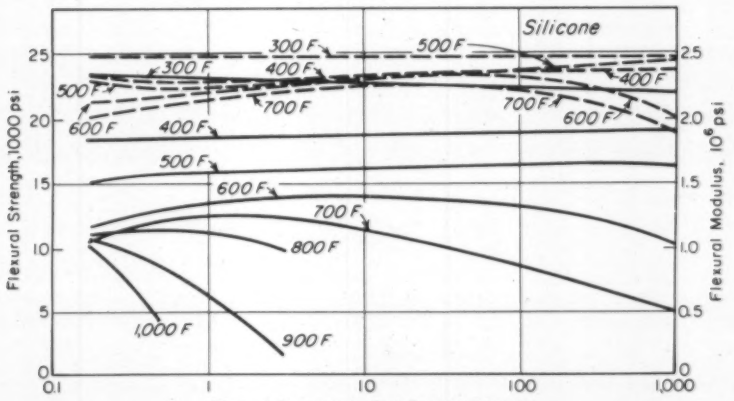






6—*Effect of heat on strength of a conventional epoxy cured with a high temperature catalyst.* (Military Handbook 17)





7—*Effects of continued exposure to heat on various high temperature reinforced laminates. All specimens were made with 181 cloth, Volan A finish, except the silicone, which was made with heat-cleaned 181 cloth. The following resins were used: Epoxy-phenolic—Epon 1001 (33 parts) and Plyophen 5023 (67 parts); Phenolic—91LD; TAC-polyester—specific type unreported; and Silicone—DC2106.* (Military Handbook 17)

Fig 6 shows mechanical strength of a conventional epoxy laminate (with high temperature catalyst) after ½-hr exposure to various temperatures. Fig 7 shows typical effects of time at temperature on properties of epoxy-phenolic, phenolic, TAC-polyester and silicone low pressure laminates. The phenolic provides the highest structural strength at 500 F, but only out to about 80 hr, after which time the silicone laminate, which started with a much lower flexural strength, is superior.

Some recent developments

Polyester resins—A relatively new TAC-polyester retains about 50% (31,000 psi) of its original (67,500 psi) flexural strength after 1000 hr at 500 F (values obtained from 12-ply 181-Garan laminates with 38% resin content). After 2000 hr at 500 F, flexural strength is still 12,000 psi. After ½ hr at 600 F, flexural strength is reported to be 22,000 psi.

Epoxy resins — Two developments in epoxy resins bear watching. One is peracetic diepoxides (Union Carbide Chemical Co.) which promise excellent heat resistance in the 500 F temperature range. Heat distortion temperatures of over 575 F (ASTM, 264 psi) have been determined after aging an unreinforced specimen for 400 hr at 500 F. Experimental laminates have provided flexural strengths of 74,700 psi at room temperature, 47,000 psi at 500 F. The materials are still developmental.

The other development is epoxy novolacs. Although epoxy novolac resins are not new, a recently introduced resin (Dow Chemical

Co.) provides heat distortion temperatures of about 500 F after aging for 120 hr at 500 F. Limited data on experimental glass cloth laminates indicate a retention of about 30,000 psi of a 90,000 psi initial flexural strength after aging for about 200 hr at 500 F. Although the resin is now commercially available, data are limited.

Silicone resins—With so many new high temperature resins being developed, the silicones are often overlooked. Initial problems in handling silicones caused reluctance on the part of many to specify them. More recent resins have improved handling characteristics at only a slight sacrifice in heat resistance. Most silicone resins are fabricated from prepreg, but solventless silicone resins are now available for wet layup.

Table 3 shows typical properties obtainable with silicone resins in low pressure laminates. Typical of the strength retention characteristics of silicone laminates are the following values (⅛-in. laminates, 181 heat-cleaned glass cloth, pressed at 350 F and 30 psi, followed by postcure):

Initial	
Flexural Str, psi	47,000
Flex Mod of Elast, psi	3,200,000
After 200 hr at 500 F	
Flexural Str, psi	
Tested at 77 F	41,000
Tested at 500 F	16,500
Flex Mod of Elast, psi	
Tested at 77 F	3,160,000
Tested at 500 F	2,420,000

More data on silicones are given in the section on electrical properties.

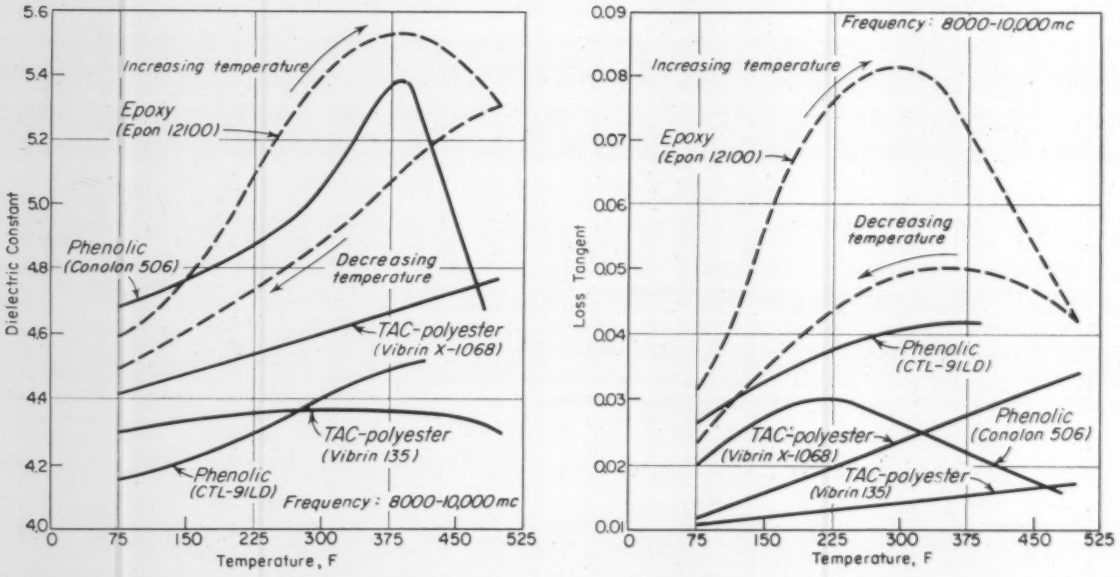
Phenolic resins—Although phenolics are among the most heat resistant resins, two major problems in their use for low pressure laminates have been the water of condensation produced during polymerization and the difficulty in obtaining good adhesion to the glass fibers. These problems have been overcome to some extent by the use of phenolics in prepreg form.

One of the most dramatic high temperature uses of phenolics has been in ablative types of missile hardware. For such uses the mechanism of decomposition of the resin is the most important criterion. Both high temperature conventional phenolics and the newer phenyl silanes have provided optimum ablation rates (i.e., lowest erosion rates) at the high temperatures (3,000-25,000 F) and high gas velocities encountered for both reentry-type nose cones and other missile components, e.g., motor liners and exhaust cones.

Both high silica glass and asbestos felts and mats have been used as reinforcements. At the higher end of the temperature range (12,000-25,000 F), some reports indicate that organic reinforcements such as nylon may provide optimum ablation rates.

Electrical properties

Industrial thermosetting laminates (high pressure laminates) are the reinforced plastics most widely used for various types of electrical insulation, e.g., printed circuit bases, slot liners and arc barriers. The critical electrical uses for low pressure laminates are primarily in parts with structural as well as electrical requirements, such as aircraft radomes and



8—*Effects of heat on dielectric constant and loss of four high temperature, reinforced plastics laminates. Tests were made at radar frequencies of 8000-10,000 mc.* (Military Handbook 17)

TABLE 3—TYPICAL PROPERTIES OF REINFORCED PLASTICS

Material →		Polyester (styrene or DAP monomer)[a]			Isophthalic Polyester (mat)[b]	Epoxy[f] (7-12 ply, 181)	Phenolic (12 ply, 181)	Silicone (⅛ in., 181)
		Cloth (12 ply, 181)	Mat (202)	Preform (30% glass)				
MECHANICAL PROPERTIES	ASTM							
Ult Ten Str, 1000 psi	D638	25-55	8-25	19-28	18.5-23	40-66	45-55	34-36
Ten Mod of Elast, 10^6 psi	D630	2.2-3.1	0.9-1.7	1.0-1.7	1.55	3.0-4.5	2.0-3.0	2.8
Ult Elong, %	D630	1.7-1.8	1.2-2.3	1.8-2.2	—	—	—	—
Ult Flex Str, 1000 psi	D790	33-75	20-40	32-45	35[c]	55-100	35-80	33-47
Flex Mod of Elast, 10^6 psi	D790	2.0-3.8	1.0-2.5	1.0-1.5	1.32-1.5[d]	3.0-4.6	3.0-4.0	2.6-3.2
Compr Str, 1000 psi	D695	27.7-45	14.5-31	20-25	—	45-52	48-52	15-24
Compr Mod of Elast, 10^6 psi	D695	—	—	—	—	3.0-4.5	—	2.5
Izod Impact Str, ft-lb/in. notch	D256	10-20	7-15	9-15	10-11 in.[e]	11-18	—	—
Hardness								
Rockwell	D785	M100-120	M80-120	M80-120	—	M102-112	—	—
Barcol		55-72	40-55	45-55	—	—	—	75
PHYSICAL PROPERTIES								
Specific Gravity	D792	1.6-2.0	1.15-2.2	1.7-2.0	1.5-2.2	1.6-1.85	—	1.75-1.8
Coef of Ther Exp, 10^{-5} per °F	D325	—	1.0-1.4	1.0-1.4	—	—	—	—
Water Absorption (24 hr), %	D570	0.2-0.8	0.2-2.0	0.2-2.0	0.2	0.02-0.07	0.3-0.6	0.03-0.5
Flammability (<0.050 in.), ipm	D635	1.0[g]	2.0[g]	2.0[g]	2.0	0.3[g]	—	0.120
ELECTRICAL PROPERTIES								
Dielectric Constant								
60 Cps	D150	3.4-6.0				4.2-5.0	[h]	3.9-4.2
1000 Cps	D150	3.4-5.8				4.9	—	—
10^6 Cps	D150	3.4-5.6				4.6	—	3.85-3.97
Dissipation Factor								
60 Cps	D150	0.01-0.05				0.004	—	0.020
1000 Cps	D150	0.01-0.05				0.005	—	—
10^6 Cps	D150	0.01-0.03				0.013	—	0.002
Dielec Str (short time), v/mil	D149	300-800				700	—	725

[a] Ranges include values obtainable in rigid, resilient and flexible types, oven cured.
[b] Laminate same as that used for auto body, i.e., 1 ply veil mat; 2 plies O-C T-219B, 1½ oz mat; 1 ply O-C T-219B, 1¼ oz mat.
[c] Wet flex strength: 2-hr boil—31,000-33,500 psi.
[d] Wet flex modulus: 2-hr water boil—1.1-1.5 x 10^6 psi.
[e] Drop ball test, reverse impact strength: no break on reverse side when impacted with ½-lb steel ball from 9-in. height.
[f] Range includes values for wet or dry layup, oven cured.
[g] Self-extinguishing types available.
[h] Low pressure phenolic laminates are not commonly used for structural electrical applications.

antennas. For these uses the primary electrical considerations are dielectric constant and loss tangent. In VHF and UHF integral antennas, loss tangent alone is critical; in separate antenna housings or radomes, both loss and dielectric constant influence design.

Table 3 shows typical electrical properties of polyester, epoxy, and silicone laminates. Factors affecting electrical properties are frequency, composition, moisture absorption, weathering and temperature.

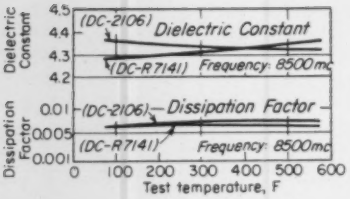
In general, dielectric constant and loss tangent of low pressure laminates decrease with increasing frequency above the VHF range. At all frequencies, they generally increase with increasing temperature, although some laminates show a decrease in values at higher temperatures. Fig 8 shows effects of heat on dielectric constant and loss tangent of several high temperature laminates.

For structural electrical applications, elevated temperatures are often encountered in service. Consequently, many of the materials studied for these applications have been high temperature resins.

Polyesters—The ease of handling of polyesters has made them highly desirable. The development of TAC-polyesters has provided relatively good heat resistance, though at some sacrifice in processability.

Epoxies—Epoxy resins provide excellent electrical characteristics, (except for a relatively high, but stable, dielectric constant), but heat resistance has been a limiting factor. The newer high temperature epoxies may be improved sufficiently to make them suitable. Epoxies have the additional benefit of extremely low moisture absorption, but more important than the degree of absorption is the effect of whatever moisture is absorbed on electrical properties. Data are limited in this area.

Silicones—Silicone low pressure laminates offer excellent electrical properties, and retain these properties to a considerable degree after exposure to both heat (see Fig 9) and moisture. For example, a typical original dielectric constant of 3.97 at 10^6 cps is reduced



9—*Effects of heat on dielectric constant and dissipation factor of two silicone laminates.* (Dow Corning Corp.)

to 3.95 after 200 hr at 480 F, and increases to 4.07 after 24 hr in water; an original dissipation factor of 0.002 at 10^6 is unchanged after 200 hr at 480 F, and increases to only 0.009 after 24-hr water immersion.

The major limitations of silicones have been their relatively low mechanical strengths and relatively poor processability. Processability improvements mentioned previously may lead to their wider use, particularly in those applications where their strength retention at high temperatures makes possible design strengths equal to or higher than those possible with materials that lose strength more rapidly.

Effects of chemicals and weather

There are, of course, a variety of other properties which must be considered in selecting a low pressure reinforced plastic for a given application. Among the most important of these are chemical resistance and weatherability.

Essentially, both of these properties are dependent on the resin used. A detailed discussion of the chemical resistance and weatherability of the various resins used in low pressure laminates is beyond the scope of this article.

Chemical resistance is dependent on many variables, such as type and concentration of reagent, type and duration of exposure (immersion, one-side, splash, fumes, etc.), and temperature of exposure. Weatherability is dependent on geographic location, angle of exposure, ozone concentration in atmosphere, direction of sun rays, etc. Although summary data on these properties are available from resin suppliers, final selection can usually only be made after service evaluation.

Although the resin is of primary importance, it is necessary to keep in mind that the materials are composed of both reinforcement and resin. In low pressure reinforced plastics, chemical resistance and weatherability will be dependent solely on the resin *only* when the part is fabricated properly. Surface gel coats or other provisions should be made to ensure that no reinforcing fiber appears on the surface. Should a fiber "surface" it will act as a wick for chemicals, and speed deterioration of the laminate.

Weathering can, in some cases, result in deterioration of the surface of properly made laminates to the extent that reinforcing fibers appear on the surface. Even in non-chemical exposures, such surface fibers may wick atmospheric moisture into the laminate, causing deterioration.

In general, epoxies have the best chemical resistance of the low pressure laminating resins. Polyesters are generally next best, with a polyester-epoxy hydrid (Atlac) providing excellent chemical resistance. Phenolics and silicones have moderate resistance to a variety of reagents.

The most recent development in weather resistant, low pressure laminates is an acrylic syrup for glass-reinforced laminates. The syrup does not provide the structural properties of other resins (flexural strength of 25,000-35,000 psi, tensile strength of 12,000-23,000 psi, flexural modulus of 0.9-1.6 x 10^6 psi), but it does provide excellent weatherability in terms of retention of color, gloss and translucency.

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Armour Research Foundation
Atlas Powder Co., Chemicals Div.
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Continental-Diamond Fibre Corp.
Dow Chemical Co.
Dow Corning Corp.
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Pittsburgh Plate Glass Co.
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Structural Fibers, Inc.
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Union Carbide Plastics Co., Div. of Union Carbide Corp.
Wright Air Development Center

References

Substantial data were obtained from *MIL-Handbook-17, Plastics for Flight Vehicles, Part I, Reinforced Plastics.* This handbook is the result of individual military programs, as well as joint Air Force and Navy support of Forest Products Laboratory studies. Data are collected under the ANC-17 Panel, a joint Air Force, Navy, Army, Federal Agency Committee.

Other helpful references were:

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first in silicones

Dow Corning

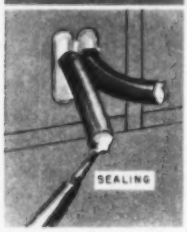
SILICONE NEWS

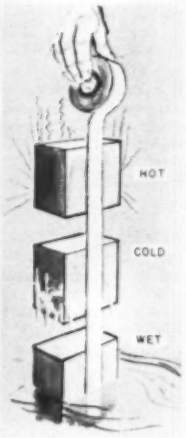
for design and development engineers • No. 71

THEY STICK!

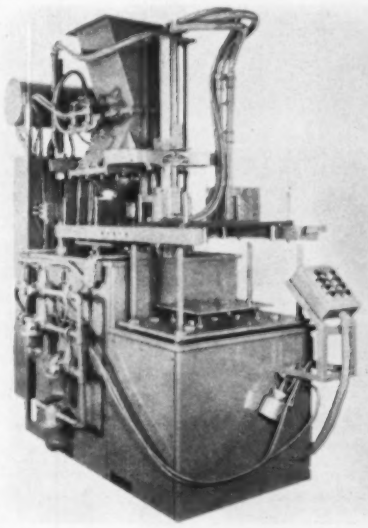
Dow Corning silicone adhesives form a good bond with practically anything . . . even wet surfaces. They produce superior pressure-sensitive tapes with most backing materials . . . serve as independent adhesives with no backing tape . . . perform diverse functions in a multitude of other applications.

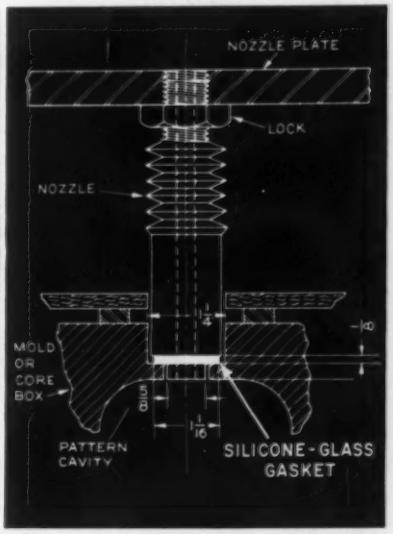
Tapes utilizing these pressure-sensitive adhesives can be applied, and will stay applied, at temperatures from —80 to 500 F. Depending on the backing material,





such tapes are useful in a variety of end uses. Some of these include: electrical insulation in aircraft, ships, power plants, generators and appliances; bonding, splicing, and sealing; masking in chemical milling; electroplating. *(Cont. Pg. 2)*





"DOUBLE-DUTY" GASKETS

Need a rigid gasket that will withstand high temperatures and high pressures, and also serve as a heat barrier? C & S Products, Detroit, recommends silicone-glass laminates. Here's why.

C & S Products manufactures the Blo-Core machine, a completely automatic unit for making resin-sand molds and cores used in the shell process of casting metals. In the Blo-Core a coated resin-sand mix is forced by air through nozzles into a heated cavity known as the hot box. A lift cylinder raises the cavity mold against the nozzles holding it there at high pressure.

In designing the unit, C & S engineers sought gasketing materials for the bottom of each nozzle that would best act as a seal to prevent metal to metal contact, act as a barrier to prevent heat transfer from cavity to the nozzle, and have high compressive strength as well as superior heat resistance to function properly. Naturally, a number of different materials were tested under these severe conditions.

The results: C & S engineers specified the use of silicone-glass gaskets made by Taylor Fibre Co., Norristown, Pa.

These washers made of woven glass fabric bonded with Dow Corning silicone laminating resins best withstood temperatures to 500 F and pressures to 15,000 psi . . . retained highest strength and maintained positive pressure after exposure. *No. 241*

PROPERTIES OF SILICONE-GLASS LAMINATES*

Property	Range
Flexural strength, flatwise, psi, ⅛-inch thickness	
Lengthwise	20,000-40,000
Crosswise	18,000-33,000
Izod impact strength, edgewise, ft-lb per inch notch	
Lengthwise	6.5-17.0
Crosswise	5.5-14.0
Bonding strength, lbs., ½-inch thickness	
Condition A	650-1100
Condition D-48/50	550-950
Water Absorption, percent	0.05

*As measured on samples ⅛-inch thick.

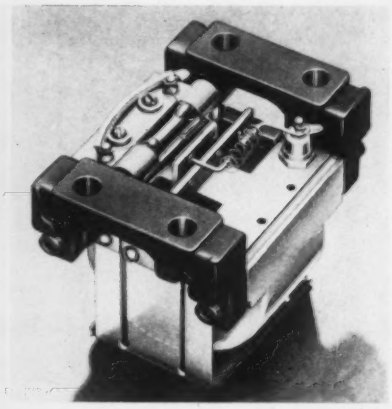
More Coffee, Anyone?

Ever wonder why the coffee served on many airliners today is prepared in just seconds . . . yet is tastier than ever? Well, here's the answer, and it involves the contributions of three different companies.

Permacel, manufacturer of tapes of all kinds, developed a silicone rubber insulating tape especially for sandwiching high temperature heater elements. Electrofilm, Inc., North Hollywood, California, used this tape in designing flexible, lightweight heating blankets. Nordskog Co., Van Nuys, California, adapted these blankets to their speedy "Little Jewel" hot liquid dispenser that serves up steaming hot coffee, tea, or soup.

In developing their PSR 2700 Heater Element for this application, Permacel engineers specified the sandwiching material be Silastic®, the Dow Corning silicone rubber.

Reason: Silastic offers excellent heat stability and resistance to oxidation; retains high insulation value and physical strength in high temperature service. Silastic provides long, reliable service. in applications *(Cont. Pg. 2)*



STOPS THE SHAKES

An example of how a silicone fluid's retention of near-constant viscosity from —40 F to +400 F helps increase the accuracy and reliability of supersonic instruments is provided by Genisco, Incorporated, Los Angeles.

Genisco produces several types of hermetically sealed accelerometers which are standard equipment on several supersonic aircraft plus a variety of missiles of the Talos, Nike-Hercules and Bomarc types. Versions of their Model DDL (illustrated above) are designed to meet MIL-E-5400 and MIL-E-5272 C.

To assure topmost accuracy and reliability, Genisco engineers immerse internal parts of the unit in low-viscosity Dow Corning 200 Fluid. This silicone fluid helps the instrument to withstand 40 G's shock on the nonsensitive axes and 100% overload on the sensitive axis.

The accelerometer's operating characteristics are virtually constant over a temperature span from —65 F to +275 F. Vibration-induced resonance of internal parts has been reduced to an absolute minimum. The parts can withstand 10G vibration without interrupting electrical continuity.

Dow Corning silicone fluid further complements the design and aids reliability by keeping the unit's potentiometer cool and lubricated so that operational life is in excess of 3 million complete cycles. *No. 243*

ADHESIVES *(Continued)*

Silicone adhesives are used alone, too. For example they've been successful in fastening electronic components together; coating ductwork in aircraft, in combination with asbestos fibers for thermal insulation; sealing the ends of heating elements in appliances; bonding aluminum foil to itself for use in cryogenic systems; bonding mica and asbestos panelboard; bonding Silastic to the coils of electrical equipment; assembling small aircraft parts or electronic components. *No. 244*

SILASTIC *(Continued)*

such as this because it withstands continuous operation from —130 F to over 500 F, and intermittent exposure to 600 F.

Because the metallic heating elements are completely enveloped and bonded between layers of Silastic-coated glass cloth, Permacel's PSR Heater Elements withstand moisture, ozone, most acids and corrosive cleaners, vibration and shock — provide longer service, tastier foods — are designed for other industrial applications. *No. 242*

new literature and technical data on silicones

Exactly What To Expect of Silastic when it's exposed to heat is thoroughly discussed in a new data sheet. The effects of high temperatures, heat aging, contact with flame, and other adverse service conditions on Silastic are reported in this valuable reference sheet. Also included are thermal properties of interest to designers of rubbery parts and components. *No. 245*

All Silicone Potting and Encapsulating materials are reviewed in a comprehensive summary reprinted from the Research and Development Handbook of Space Aeronautics. An easy-to-read table lists uses and engineering data on various physical forms of silicone potting and encapsulating materials including rigid, elastomeric, gel, greaselike, and fluid dielectrics. The expansive table and concise descriptions are available for your reference. *No. 246*

Rubber From Rock, a full color sound movie, points up ways you can use silicone rubber to improve performance and design of mechanical and electrical equipment. It explains how Silastic, the Dow Corning silicone rubber made from quartzite, retains its rubber-like properties from —130 to over 500 F in automotive, aircraft and industrial applications. *No. 247*

Designs on the Moon. Created specifically to meet the informational needs of rocket and missile designers, an illustrated brochure describes the finest in silicone materials — rigid, rubbery, fluid and dielectric. Whether you're concerned with nose cones, guidance frames, propulsion, or ground supports, your most rapid progress toward miniaturization, weight reduction, and reliable performance may result from specifying silicone products. *No. 248*

Do You Know How silicone resins, rubber, oils and greases are being used to advantage in appliances? A six-page reprint from Electrical Manufacturing relates how extreme temperature resistance properties of silicones have been used in the designs of toasters, refrigerators, irons, portable power tools, percolators and other appliances. *No. 249*

Compiled for Advanced Research and development engineers, an eight page reference provides a convenient guide to selecting the most suitable silicone fluid medium when designing damping, springing, coupling and related mechanical devices. Includes tables, graphs and detailed information about properties that enable Dow Corning silicone fluids to increase efficiency of existing designs and make possible new design changes. *No. 250*

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FILE FACTS

Resistance of Titanium to Chemical Corrosion[a]

Chemical	Conc, %	Temp, F	Corrosion Rate, ipy
ACIDS			
Acetic	33	Boiling	Ni
Acetic-Glacial (liquid)	99.7	Boiling	Nil
Acetic-Glacial (vapor)	99.7	Boiling	Nil
Aqua Regia	[b]	Room	Neg
	[b]	170-175	0.034
Boric	Sat'd	Room	Nil
Chromic	20	Room	Nil
Citric	Sat'd	Room	Nil
Formic	50	Boiling	0.06
	87	Boiling	Nil
Hydriodic	57	Room	0.006
Hydrobromic	40	Room	Nil
Hydrochloric	1	100	0.0008
	1	200	0.001
	5	100	0.013
	5	200	0.288
	10	100	0.031
	10	200	0.972
	20	100	0.056
	20	175	2.640
	37	100	0.708
Hydrochloric (1% $CuSO_4$)	5	100	0.0001
	5	200	0.004
Hydrochloric (5% $CuSO_4$)	5	100	0.001
	5	200	0.002
Hydrochloric (1% CrO_3)	5	100	0.001
	5	200	0.001
Hydrochloric (1% HNO_3)	5	100	Nil
	5	200	0.004
Hydrochloric (5% HNO_3)	5	100	Nil
	5	200	0.004
Hydrochloric (10% HNO_3)	5	100	Nil
Hydrofluoric	1	Room	59.52
	48	Room	2112.0
Hydrofluoric-Nitric	[c]	Room	696.0
Lactic	85	Boiling	Neg
Nitric	65	Boiling	0.002
Nitric (2% HCl)	65	Room	Nil
Nitric, Red Fuming (liquid or vapor)		Room	Neg
Nitric, White Fuming (liquid or vapor)		Room	Nil
Oxalic	Sat'd	Room	0.02
Phosphoric	10	100	0.001
	10	Boiling	0.380
	50	150	0.24
	85	100	0.048
Phosphoric + Copper Sulfate	50	150	0.014
Phosphoric-Sulfuric	[d]	150	0.228
Phosphoric-Sulfuric + Copper Sulfate	[d]	150	0.004
Stearic	100	356	0.001
Sulfuric	1	100	0.014
	1	200	0.180
	5	100	0.024
	5	200	0.408
	20	100	0.076
	20	200	1.104
	30	100	0.078
	30	200	7.032
	50	100	0.192
	50	200	10.45
	70	100	2.844
	70	200	14.01
	95	100	0.192
	95	200	5.916
Sulfuric (1% $CuSO_4$)	5	200	Nil
	30	100	0.001
	30	200	0.035
Sulfuric (10% $CuSO_4$)	30	100	0.016
	30	200	0.025
Sulfuric (20% $CuSO_4$)	5	100	Nil
	5	200	0.003
Sulfuric (1% CrO_3)	5	200	Nil
	30	200	Nil
Sulfurous	6	Room	Nil

Chemical	Conc, %	Temp, F	Corrosion Rate, ipy
SALTS			
Aluminum Chloride	25	Boiling	0.144
Aluminum Fluoride	Sat'd	Room	Nil
Aluminum Nitrate	Sat'd	Room	0.0006
Aluminum Sulfate	Sat'd	Room	Nil
Aluminum Sulfate (1% H_2SO_4)	Sat'd	Room	Nil
Aluminum Sulfate (1% Na_2CO_3)	Sat'd	Room	Nil
Ammonium Hydroxide (liquid)	28	Room	Nil
Ammonium Perchlorate	15-20	80-190	Nil
Ammonium Sulfate (0.5% H_2SO_4)	Sat'd	Room	0.0004
Ammonium Sulfate (5% H_2SO_4)	Sat'd	Room	0.0007
Calcium Hydroxide	Sat'd	Room	Nil
	Sat'd	Boiling	Nil
Copper Cyanide (Plating Sol'n)	—	Room	Nil
Copper Nitrate	Sat'd	Room	Nil
Copper Sulfate (2% H_2SO_4)	Sat'd	Room	0.0007
Cupric Chloride	Sat'd	Room	Nil
Ferric Chloride	10	Room	Nil
Ferrous Sulfate	Sat'd	Room	Nil
Lead Acetate	Sat'd	Room	Nil
Potassium Bromide	Sat'd	Room	Nil
Potassium Chloride	Sat'd	Room	Ni
Potassium Ferricyanide	Sat'd	Room	Nil
Potassium Iodide	Sat'd	Room	Nil
Potassium Permanganate	Sat'd	Room	Nil
Sodium Acetate	Sat'd	Room	Nil
Sodium Aluminate	25	Boiling	0.004
Sodium Bifluoride	Sat'd	Room	Rapid
Sodium Bisulfate	Sat'd	Room	0.004
	10	150	0.072
Sodium Bisulfite	10-25	Boiling	Nil
Sodium Carbonate	10-25	Boiling	Nil
Sodium Chlorate	10-25	Room	Nil
	Sat'd	Room	Nil
Sodium Chloride (salt spray)	20	95	Nil
Sodium Chloride	Sat'd	Room	Nil
Sodium Citrate	Sat'd	Room	Nil
Sodium Cyanide	Sat'd	Room	Nil
Sodium Dichromate	Sat'd	Room	Nil
Sodium Fluoride	Sat'd	Room	0.0003
Sodium Hypochlorite	6	Room	Nil
Sodium Nitrate	Sat'd	Room	Nil
Sodium Nitrite	Sat'd	Room	Nil
Sodium Phosphate	Sat'd	Room	Nil
Sodium Silicate	25	Boiling	Neg
Sodium Sulfate	10-25	Boiling	Nil
	Sat'd	Room	Nil
Sodium Sulfide	Sat'd	Room	Nil
Sodium Sulfite	10	Boiling	Nil
	Sat'd	Room	Nil
	Sat'd	Boiling	Nil
Sodium Thiosulfate	10-25	Boiling	Nil
Sodium Thiosulfate (20% acetic acid)	20	Room	Nil
Stannic Chloride	25	Boiling	Nil
	100	Molten	Nil
Sulfur Chloride	Conc	Room	Diss
Sulfur Monochloride	Conc	Room	Diss
Titanium Tetrachloride	Conc	Room	Neg
Zinc Chloride	Sat'd	Room	Nil
Zinc Sulfate	Sat'd	Room	Nil
MISCELLANEOUS			
Benzene (Liquid)		Room	Nil
Bromine Water		Room	Nil
Carbon Tetrachloride (liquid)		Boiling	Nil
Carbon Tetrachloride (vapor)		Boiling	Nil
Ethyl Alcohol (liquid)		Room	Nil
Iodine in Alcohol	Sat'd	Room	Pitted
Iodine in Water + Potassium Iodide		Room	Nil
Phenol		Room	Nil
Potassium Hydroxide	25	Boiling	0.012
	50	Boiling	0.108
Sodium Hydroxide	Sat'd	Room	Nil

[a]Commercially pure grade. Neg = negligible, Diss = dissolved. [b]3HCl : 1HNO_3. [c]1HF : 15HNO_3. [d]15H_3PO_4 : 10H_2SO_4.

Source: Titanium Metals Corp. of America.

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MATERIALS AT WORK

...AT A GLANCE

A new type of automobile seat combines metal springs and urethane foam in one integral unit. According to the developer, the seat provides "the best features of spring construction with the design advantages of urethane foam, at lower cost."
Source: Reynolds Chemical Products Div., Stubnitz-Greene Corp.

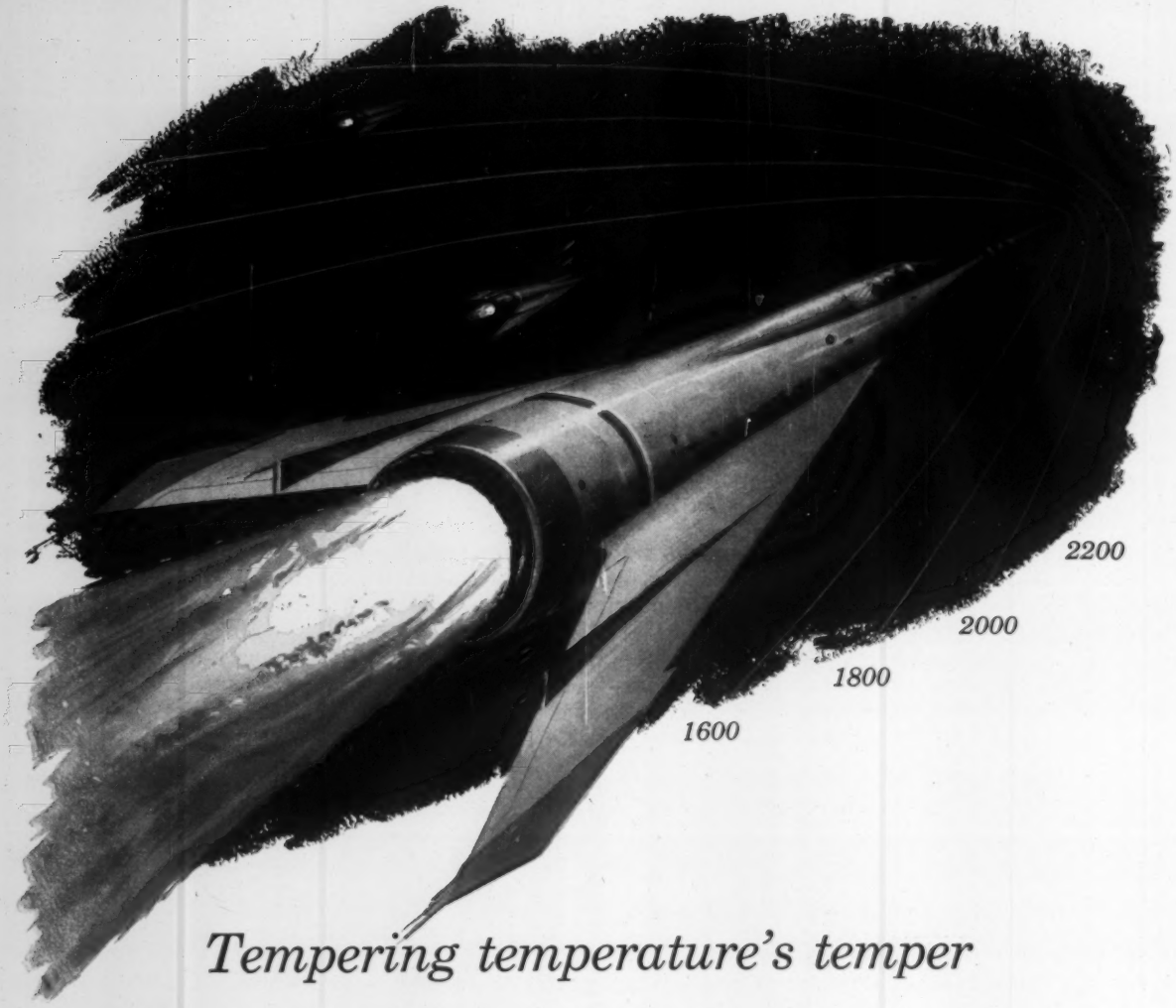
Electronic miniaturization has taken another step forward with the development of the Micro-circuit—a unit smaller than a postage stamp yet capable of providing resistance, capacitance and inductance. The units consist of very thin (200-2000 angstrom units) layers of nickel-chromium, tantalum, tungsten or other conductive alloys vacuum deposited on a tiny glass substrate. For use as a capacitor, thin films of various oxides are used. Glass was selected for the substrate in preference to ceramics or plastics because of its good structural strength and smooth surface.
Source: International Resistance Co.

Hundreds of tiny stainless steel tubes will play a key role in the operation of the Air Force's first nuclear power plant. Heart of the system is the fuel "core" made up of thin wall, ½-in. dia tubes. The wall of each tube consists of three layers: an inner and outer stainless steel cladding and an interior of uranium oxide mixed with stainless steel powder. The tubes are treated so that the three layers fuse together into a single substance.
Source: Nuclear Div., Martin Co.

Tungsten coatings are protecting graphite rocket nozzles at temperatures up to 5500 F. Originally, it was felt that a rhenium undercoat was necessary to reduce the formation of tungsten carbide which has a lower melting point (4500 F) than pure tungsten (6100 F). However, rhenium's high cost and limited supply led to the selection of a tantalum undercoat. Further tests showed that by applying the tungsten with the plasma arc technique, undercoats could be eliminated altogether because the coating particles have a higher density and form a better bond to the graphite.
Source: Linde Co., Div of Union Carbide Co.

Aluminum applications in automobiles continue to increase. This year, each new car will use an average of 56.2 lb, up more than 10% from last year's 49.6 lb. Two of the latest applications are Corvair's 6-cylinder engine and Pontiac's integrated wheel hub and brake drum. By 1961, aluminum is expected to be used for mufflers, bumpers and radiators.
Source: Kaiser Aluminum & Chemical Corp.

Simulated 'porpoise skin' may someday increase submarine speeds to 180 knots (about 207 mph). The skin, which is actually a rubber coating, is said to reduce drag due to turbulence by as much as 90%. The coating consists of a thin rubber layer supported by many tiny rubber pillars which are interconnected by a series of channels containing a freely flowing viscous liquid. When turbulence occurs, the liquid flows inside the coating and dampens the turbulence.
Source: U. S. Rubber Co.; coating invented by Dr. Max O. Kramer, Coleman-Kramer, Inc.



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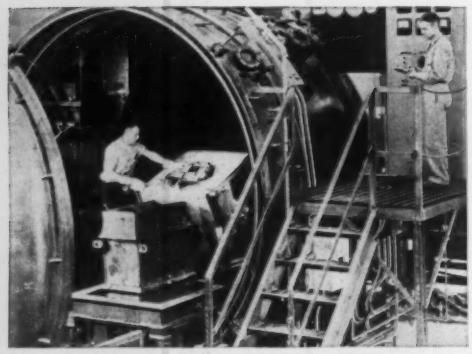

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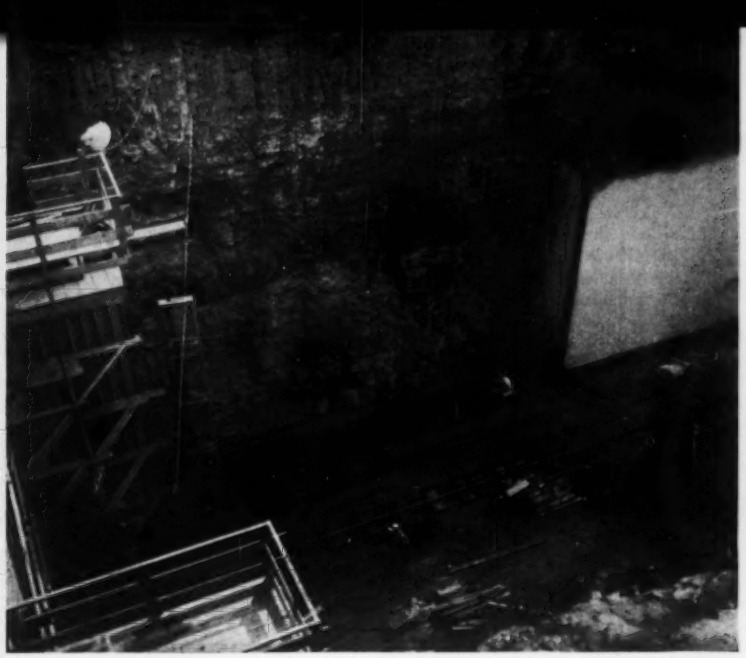


Broad view of the power tunnel *under construction shows a poured concrete vertical wall at the right and part of the mobile scaffold at the left. The black band running between is the asphalt-covered strip of sheet lead.*

Strips of lead sheeting *are cut into 10-ft lengths and placed, with ends butted, over the surfaces that have been painted with an asphalt emulsion. The lead sheeting is 2 ft wide, 1/16 in. thick and weighs 4 lb per sq ft.*

Lead Sheet Forms Lubricating Seal

at concrete joints of water conduits

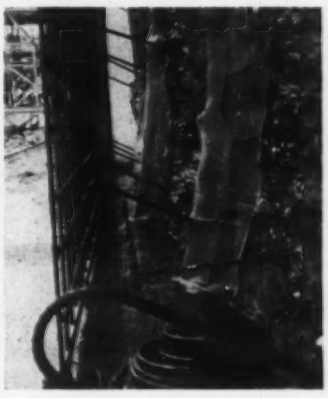
■ Lead sheet plays an interesting role in the fabrication of the 66-ft high, 44-ft wide conduits that will carry water diverted from the Niagara River to the Niagara Power Project. Massive sections of the wall are being poured at each stop of a mobile scaffold which carries concrete forms on either side.

Sheet lead is placed in the right-angle butt joint formed between the vertical concrete wall sections and the flat concrete base. In addition to acting as a water seal for the joint, the lead serves as lubricant during wall movements due to stress induced by contraction or expansion of the formed concrete.

Lead was one of several materials that were suitable from the standpoint of high malleability and lack of resilience. Further study, however, singled out lead as the final selection because of its lubricity and ability to carry the design loads. Additional advantages were gained because lead is easily cut and worked, and is low in cost.

These pictures of the Niagara Power Tunnel were supplied by Lead Industries Assn.

Protective coating of asphalt emulsion *is applied to the lead strips to prevent reaction with the free lime in the curing cement. The total lead used on both sides would form a continuous strip over 16.5 miles long and weighing 352 tons.*



Gridwork of steel reinforcing bars *is anchored in the rock wall and the mobile scaffolding rig is moved up preparatory to pouring another concrete wall section on top of the asphalt-covered lead lubricating seal.*

Corrosion resistance

Platinum itself is virtually unaffected by all acids except 1) combinations in which hydrochloric acid or chlorine are present under oxidizing conditions, and 2) slight attack by concentrated sulfuric acid at elevated temperatures. It resists most oxides, alkalis and salts, and is unaffected by liquid and solid organic materials. However, it is subject, in reducing atmospheres, to formation of low melting alloys or compounds with metals such as lead, zinc and antimony.

Other members of the platinum family are also highly corrosion resistant. Iridium is the most corrosion resistant element known and, in compact form, is insoluble in all acids, including aqua regia. Rhodium is also highly resistant to acid attack. Palladium is not as corrosion resistant as platinum but, because of its lower cost, is widely used for selected applications.

1. **Crucibles** of platinum are familiar in the laboratory. Not so familiar: their use for growing large (up to 30 lb and 12 in. dia) single crystals of various salts.

2. **Spinnerettes** or multiple extrusion dies, used to spin rayon filament, must withstand erosive and corrosive action of cellulose and coagulating solutions. Die may have 30,000 orifices as small as 0.002 in. dia, with a tolerance of 0.0001 in. The alloys 30:70 platinum-gold or 90:10 platinum-ruthenium are usually used. The platinum-gold alloy can be age hardened after forming to increase erosion resistance.

3. **Equipment for molten glass** requires platinum, since it is the only metal free from attack by molten glass, does not contaminate the product, and has sufficient strength at elevated temperatures. Some uses: sheathed refractories, pots, paddles, pouring spouts and bushings. A 10% rhodium alloy is used for greater hot strength in bushings. (At 1830 F, tensile strength of platinum is 4500 psi; of platinum-10% rhodium, about 14,000 psi.)

4. **Glass-to-metal seals** often use platinum because its coefficient of expansion is the same as that of many types of glass—especially when resistance to corrosion and high temperatures is also needed.

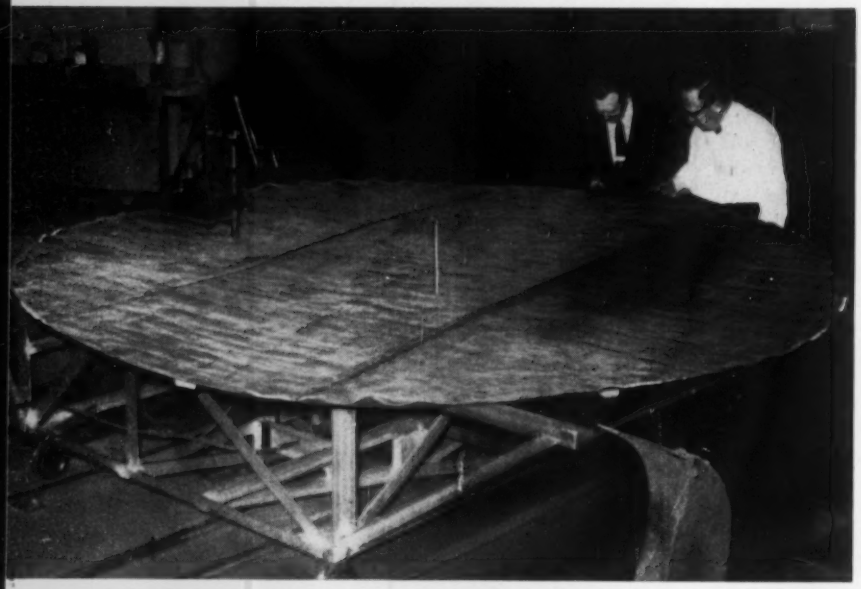
Catalysis

The platinum metals offer several distinct advantages over other metals: 1) sometimes they are the only effective catalyst; 2) chemical reactions proceed at a good rate at lower temperatures and pressures, making possible less expensive plant design; 3) their excellent stability keeps downtime and maintenance to a minimum; 4) since metal losses due to attrition or loss in the product stream are normally small, product purity is high; and 5) the spent catalyst can be recovered and reused at nominal cost.

1. Supported platinum catalysts are used to reform molecules in gasoline stocks to increase octane rating.

2. Precious metal catalysts are used to form or modify complex organic molecules in production of vitamins, antibiotics, steriods, etc.

3. A platinum or platinum-rhodium gauze is used in the oxidation of ammonia vapor in practically all nitric acid production. (Approximately 50 tons of acid are produced from each ounce of platinum gauze before the gauze becomes ineffective.)



Ammonia oxidation gauze, *measuring almost 10 ft in dia, has been woven of a platinum-rhodium* ***alloy.***

Where To Use

Platinum Group Metals

These precious metals and their alloys may be cheaper than you realize—if you think in terms of their long life, their ease of fabrication, and their high recovery rate.

by S. S. Rice, *Chief Metallurgist, J. Bishop & Co.**

Resistance to surface film formation

(plus high temperature stability)

Platinum and rhodium are virtually free from oxide or other surface film formation. Other members of group show only small amounts of surface oxide formation over narrow and specific temperature ranges. As a result, these metals and their alloys are applied where a bright metallic surface must be maintained during long exposure to oxidizing and tarnishing environments. In addition, platinum and rhodium, as they approach their melting points, show little weight loss due to formation of volatile oxides.

1. **Electrodes** of platinum serve as insoluble anodes under a wide range of conditions. Platinum has often replaced graphite to eliminate anode-cathode gap changes and erosion contaminants, and to increase impact resistance and current densities.

2. **Cathodic protection** of ships against salt water corrosion can be obtained by passing a controlled electric current from a small platinum anode through the sea to the hull.

3. **Platinum cladding** 0.00001 in. to 0.01 in. thick over titanium provides an electrode with the characteristics of platinum at less cost. Should cladding break, titanium will not usually corrode and there is no measurable change in anode activity. Alternative base metals: tantalum, columbium and zirconium.

4. **Electrical contacts** must carry current without overheating, interrupt a circuit without excessive deterioration, and in many cases maintain low and constant contact resistance. Contacts of platinum are used in telegraph transmitters, alarm systems and temperature controllers; palladium in telephone relay contacts; platinum-iridium in sliding contacts for wear resistance; and rhodium or rhodium plate in RF circuits as well as sliding contacts.

Other important uses

Hydrogen diffusion

Palladium can absorb and diffuse large amounts of hydrogen. Selective absorption and diffusion of hydrogen through a palladium membrane is used in hydrogen determinations, gas separation, and preparation of pure hydrogen.

Magnetic materials

Platinum-cobalt alloys are well known for their magnetic properties. The alloy containing 76.7% platinum and 23.3% cobalt by weight (or 50 at. % each of platinum and cobalt), when properly heat treated, is an extremely powerful permanent magnet. Exhibiting a very high coercive force and maximum energy product, it offers a BH (max) of 9.2 x 10^6 gauss-oersteds, almost twice that of Alnico V. It is comparatively workable before heat treatment.

Resistance to high temperatures

Platinum metals serve as protective coatings for missile nose cones, jet engine fuel nozzles, and tungsten and molybdenum. More familiarly, they are used in furnace windings and ignition systems which must perform reliably for long times at high temperatures.

Temperature measurement

1. **Thermocouple combination** of platinum-10% rhodium and platinum-13% rhodium is well known. It provides continuous service up to 2550 F, intermittent service to 2900 F, and can be used for quick immersion at 3100 F. The combination of platinum-5% rhodium and platinum-20% rhodium provides continuous service to 3100 F and has an absolute limit of 3315 F for single determinations.

2. **Resistance wires** of platinum form the heart of high temperature resistance thermometers.

Alloying to increase corrosion resistance

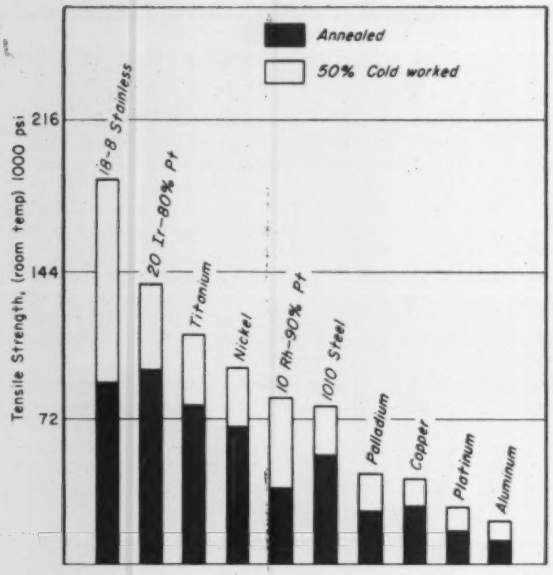
Dr. M. Stern of Union Carbide Metals Co. found that the introduction of as little as 0.1 wt % palladium to titanium reduces the corrosion potential of titanium by 98%. Russian workers say the addition of small amounts (0.1-0.9%) of platinum and palladium to types 302 and 446 stainless steels greatly increases their resistance to sulfuric acid.

■ Platinum and the platinum group metals—palladium, iridium, ruthenium, and osmium — have graduated from the chemical laboratory and are now widely accepted industrial metals. Since World War II, annual world production has increased from ½ million troy ounces to over 1 million troy ounces.

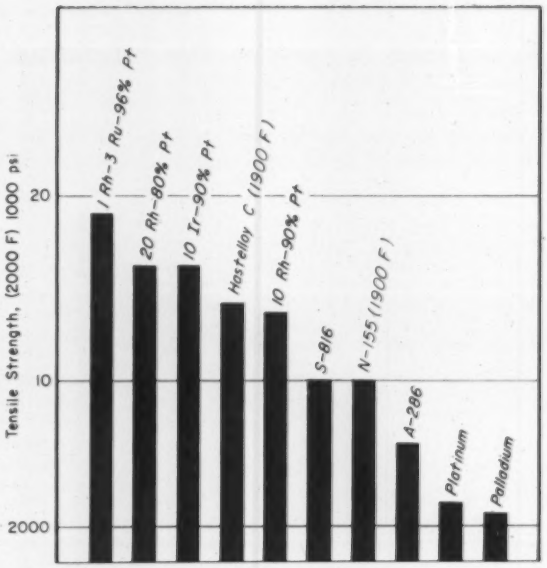
This increase in popularity can be attributed to increased awareness by engineers of three factors: the platinum group metals frequently offer properties superior to those of competitive materials; they are, at times, the only materials that can meet the service requirements; and, despite their initial high cost, they are often the most economical choice.

The economies realized with the platinum metals are a result of their ease of fabrication, their

* *The author is now associated with Bridgeport Brass Co.*



Tensile strength at room temperature.



Tensile strength at 2000 F.

extended service life, and the high recovery rate possible by refining the used metal. For example, approximately 99% of returned platinum is recoverable, with the recovery cost set at less than 4% of the market value. Because of price increases, the platinum user often receives more for the worn equipment than it originally cost.

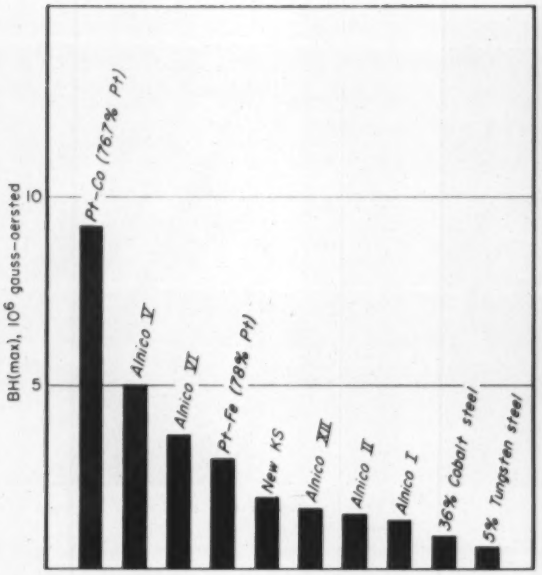
Both platinum and palladium can be worked by normal metal working processes. Iridium and rhodium are worked only with difficulty, and osmium and ruthenium are practically unworkable, although all four metals can be alloyed with platinum and palladium to provide easily fabricated alloys with a wide range of properties. The accompanying table shows some physical and mechanical properties of the platinum group metals and certain of their alloys.

All metal forms, from castings to sheet products, are available. Expanded metal, fine wire (as small as 0.00004 in. dia), foil, tubing, etc. are easily produced.

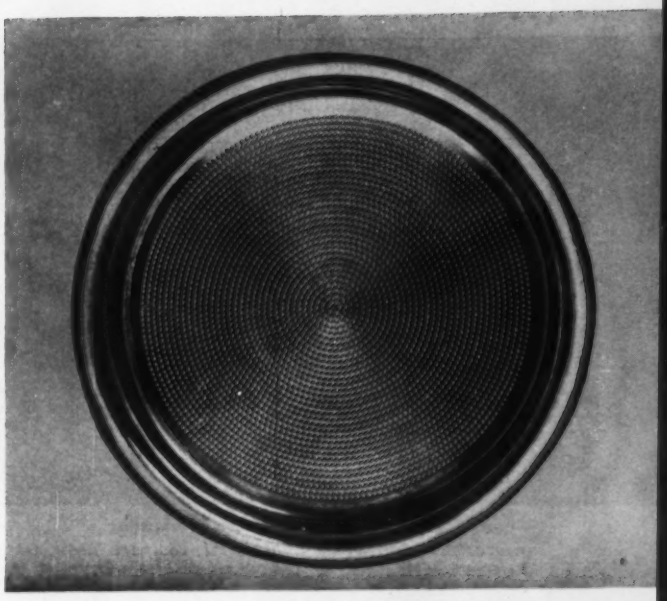
PHYSICAL AND MECHANICAL PROPERTIES OF PLATINUM GROUP METALS

	Platinum (physically pure)	Palladium	Iridium	Rhodium	Ruthenium	Osmium	95 Pt, 15 Ir	90 Pt, 10 Ir	80 Pt, 20 Ir
Density (68 F), lb/cu in.	0.775	0.434	0.813	0.449	0.441	0.813	0.776	0.778	0.781
Melting Point, F	3216	2826	4449	3571	4350 (approx)	4892	3227-3245	3236-3272	3290-3362
Ther Cond (32-212 F), Btu/ft/in./°F/hr	480	493	406	618	—	—	2150	1220	—
Ther Coef of Exp (32-212 F), 10^{-6} per °F	4.94	6.50	3.61	4.6	5.33	3.33	—	4.94 (68 F)	—
Spec Ht, Btu/lb/°F									
32 F	0.0315	0.0584	0.0307 (68 F)	0.058	0.057	0.0309	—	—	0.030
212 F	0.0325	—	—	—	—	0.0314	—	—	—
Elec Res, ohms/cir mil-ft									
32 F	58.86	60.0	—	30.1	47	54	—	—	—
68 F	63.60	64.8	—	—	84	57.1	114	150	192
212 F	81.90	—	—	—	—	—	—	—	—
Mean Temp Coef of Res (32-212 F), per °F	0.00392	0.0037	0.00392	0.00457	—	0.0042	0.0019	0.0012	0.0008
Tensile Strength, 1000 psi									
Annealed	17-19[a]	28	21	80	—	—	40	55	97
50% Reduction	34[b]	47	—	360	—	—	70	95	150
Vickers Hardness*									
Cast	45	49	183	147	231	362	—	—	—
Annealed	42	46	189	144	310	381	78	110	—
50% Reduction	106	118	351	401	—	—	149	215	245

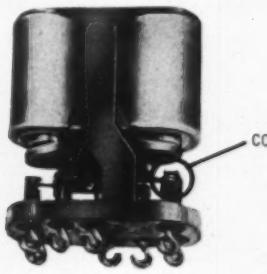
[a]Comparable value for chemically pure grade: 20-23,000 psi. [b]Comparable value for chemically pure grade: 35,000 psi.



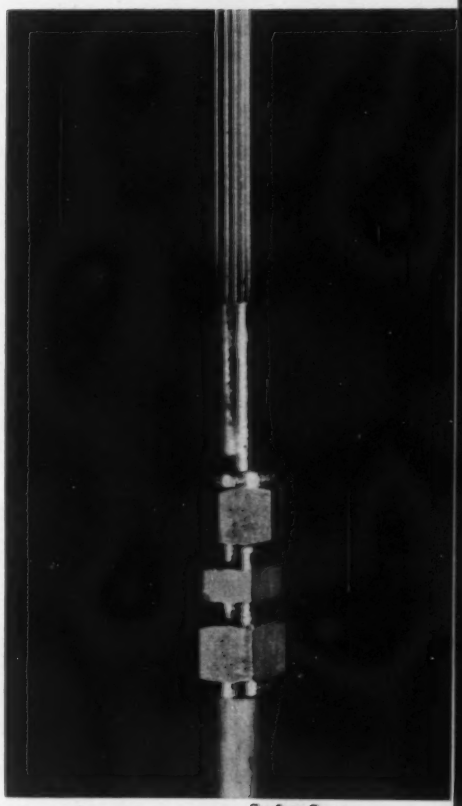
Maximum energy products (BH_{max}).



Spinnerette *of platinum used to spin rayon filaments.*



Contacts *of gold-faced palladium alloy are used in this relay.*
Potter and Brumfield



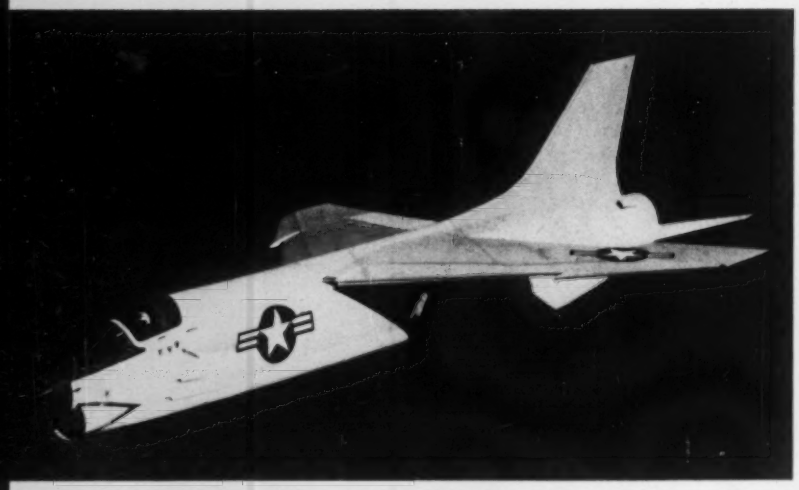
Serfass Corp.

Tube cluster *of palladium-silver forms the heart of a hydrogen purification unit.*

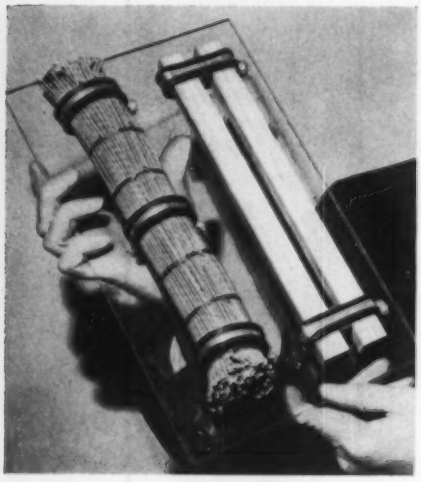
AND SOME OF THEIR ALLOYS

	75 Pt, 25 Ir	95 Pt, 5 Rh	90 Pt, 10 Rh	80 Pt, 20 Rh	95 Pt, 5 Ru	90 Pt, 10 Ru	60 Pd, 40 Ag	60 Pd, 40 Cu
	0.783	0.746	0.722	0.677	0.747	0.722	0.408	0.383
	3398-3470	3308	3362	3452	—	—	2426-2534	2185-2235
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
	—	—	114.0	—	—	—	—	210 (ann. and quenched)
	198	105	115.2	124.8	189	258	252	21 (aged)
	—	—	—	—	—	—	—	—
	0.0006	0.0015	0.0017	0.0014	0.00085 (8-212°F)	0.00083 (8-212°F)	0.00002	0.00032 (ann.) 0.000224 (ordered)
	125	30	47	70	60	85	54	82
	170	70	84	130	115	150	100	193
	—	—	—	—	—	—	—	—
	69	—	—	120	125	173	89	99
	77	—	—	215	211	—	183	250

[c]Similar to Brinell: 10-mm ball, 3000-kg load.



Chance Vought's new F8U-2N Crusader *will be first production aircraft to incorporate lightweight, compact harness system.*



Comparison of old and new *harness systems. Molding of harness in glass cloth-polyester resin sheath cuts weight by 10 to 15%, space by 30 to 40%.*

Glass-Reinforced Plastic Harness Cover

drastically cuts wiring weight and space

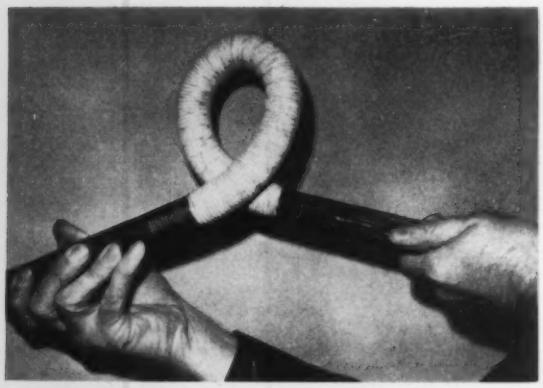
■ A new wire harness designed to eliminate many electrical, weight and space problems in aircraft and missiles has been developed by Chance Vought Aircraft, of Dallas. In the new harness, bundles of Teflon-insulated wires are completely encased in a tough, rigid and compact cover of polyester-impregnated glass cloth.

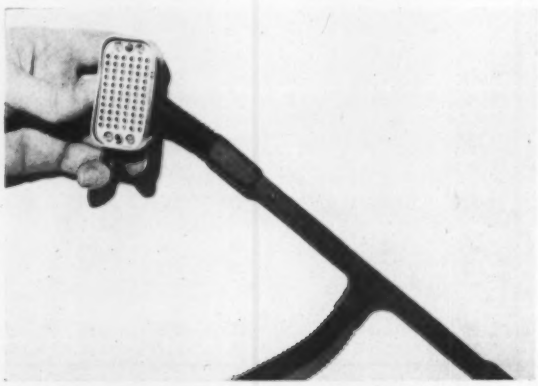
How harness is made

The harness is formed by wrapping the preimpregnated cloth around the wires and molding the entire assembly under heat and pressure. Most of the resin stays in the surface layer; however, some of it penetrates between individual wires. Although a polyester impregnant is presently being used, it is expected that other materials such as silicone, phenolic and epoxy resins will be practical, depending on the ambient temperature expected.

How it compares

The new harness system will have its first service application in Vought's new F8U-2N, where it will provide a 10 to 15% weight saving and a 30 to 40% volume reduction over conventional harness designs. For example, a conventional harness consisting of 360 wires of a given gage forms a bundle 2⅝ in. in dia or, if divided into six smaller bundles, a package 3⅜ in. deep by 2¼ in.





Flexible takeoffs *of vinyl, Teflon or rubber aid joining of main harness with connectors and secondary harnesses.*

wide. In contrast, the same number of wires of the same gage can be carried in a molded harness section only 1⅝ in. deep by 1½ in. wide. At present, the molded harness is mainly used for routing main bundles, and appears to be most practical for large bundles carrying more than 40 to 50 wires.

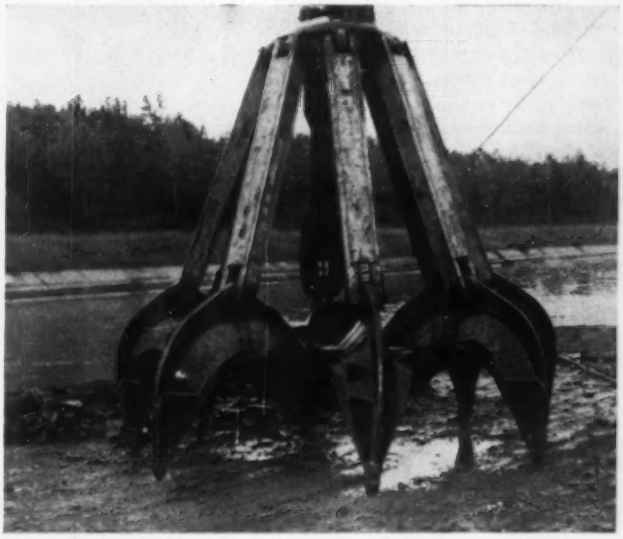
In addition to its weight and space savings, the new system is expected to eliminate the problems of chafing, broken wires, accidental damage, and the effects of vibration (harnesses have been vibrated from 5 to 500 cps at 10 g's for 3 hr without failure). Furthermore, wires encased in the molded harness can withstand much higher electrical overloads and temperatures. No damage occurs when 22-gage wire rated at 5 amp is overloaded to 25 amp for 2 min.

Tests show that if an individual wire is overloaded because of equipment failure it will invariably fail outside the molded section. Fire hazard is lessened and the trouble spot is easy to locate.

The molded harness can be designed much like a structural member into an aircraft or missile (it also can be molded into the form of an external aerodynamic fairing). Location of the harness can be predicted with a few hundredths of an inch, an accuracy impossible with conventional loose wire harnesses which are snaked through aircraft interiors. Extra wires can be included in the molded harness as spares or to provide for installation of additional equipment. Where a group of wires divide off the main bundle a flexible takeoff of vinyl, Teflon or rubber tubing can be incorporated.

Other uses expected

In addition to aircraft and missiles, the new harness is also expected to have application in computers and other high-density electronic equipment, as well as for external wiring for factories, offices and homes. Applications are also envisioned for surface ships, submarines, tanks, automobiles and earthmoving machines.



Change of Welding Electrode Lengthens Grab Bucket Life

■ This grab bucket is used to extract crushed rock from a canal bed. Welding of the austenitic manganese steel points to the 1020 carbon steel plate teeth was formerly done with an electrode of the 300 series stainless steel group. Best life was 2 to 3 weeks. When electrodes of nickel-manganese-iron alloy (Wall Colmonoy Walmang No. 3) were substituted, point life increased to 4 to 6 weeks. The electrodes were applied by d.c. electric arc welding with reverse polarity. The operation proved less expensive and less time-consuming than formerly. Overlaying the point surface with a hardsurfacing electrode also increased service life by reducing abrasive wear. Photo at the right shows the neat joint and the hardsurfaced tip.

OTHER CONTENTS

Stainless-Teflon Hose Is Flexible 132
Aluminum Linings Used in Trawlers 132
Fiberglass Insulates Transformer 136
Polyester Dye Tanks Eliminate Leaks..... 136
Synthetic Sapphire Rod for Wave Tubes..... 138

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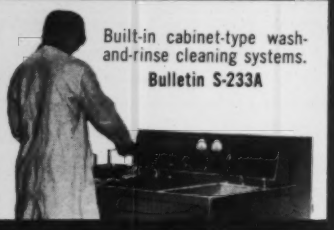

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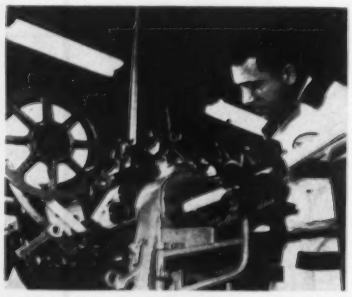
***Flexible hose** (upper left) allows Jupiter engine to be tested on pivots where the thrust can be measured without the drag caused by rigid piping.*

Stainless-Teflon Hose Is Flexible

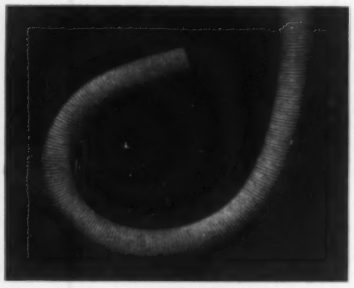
A relatively new type of flexible hose, consisting of a TFE-glass laminated inner core and stainless steel wire reinforcement, is being used for a variety of applications in advanced aircraft and missiles, and in the petroleum, chemical and steel industries.

The hose, which has a bend radius of only three times its i.d., is capable of operating at temperatures ranging from —65 to 400 F and is available in diameters up to 2 in. It is currently being used to convey corrosive fluids under high pressure in Thor, Jupiter, Redstone, Juno and Atlas missiles; to convey air, hot water, steam and oxygen in open hearth furnaces; and to carry steam to platen presses used in the manufacture of rubber tires, automotive trim and footwear.

According to Titeflex, Inc., the hose gets its exceptional flexibility and corrosion resistance from a unique manufacturing technique. Unlike most Teflon hose, the inner core is not extruded. Instead, unsintered TFE tape and TFE-impregnated glass tape are wrapped and fed into a die which forms the laminated structure into helical convolutions (see accompanying photos). The structure is cured in an electric oven and water quenched. Type 304 stainless wire braiding is then applied.

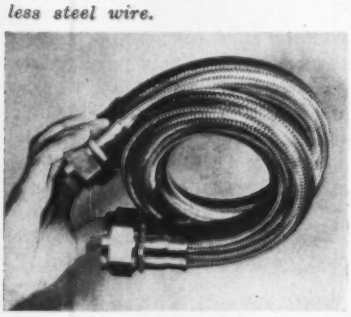


***1** TFE tape and TFE-coated glass fiber tape are wrapped around mandrel, cured and fused into . . .*



***2** . . . inner core which is . . .*

***3** . . . covered with braided stainless steel wire.*

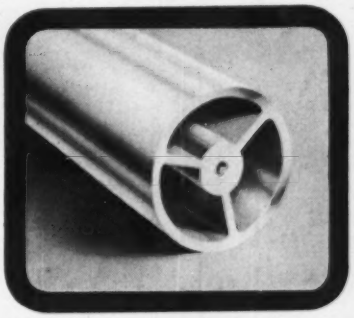


Aluminum Linings Now Used in Trawlers

Aluminum is now being used in place of wood for hold linings and pen boards in fishing trawlers.

According to Kaiser Aluminum &

WHITELIGHT MAGNESIUM



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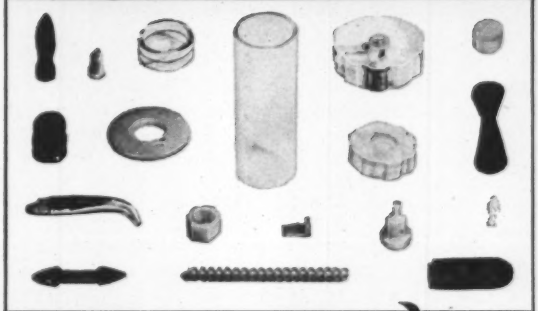

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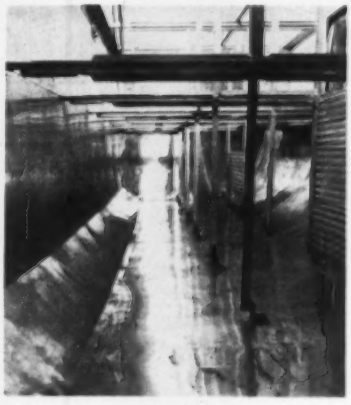
Chemical Corp., the switch to aluminum has resulted in reduced maintenance, better ice preservation, lower bacteria count, less color, reduced weight, reduced spoilage, and improved lighting. Aluminum sheet is used for the hold linings, and aluminum extrusions with a ribbed configuration are used for the pen-boards (see accompanying photos).

Because aluminum has excellent thermal properties, the new hold has a maximum cooling rate and thus does not require as much ice for refrigeration. Maintenance costs and downtime are reduced because the aluminum hold and pen boards do not require traditional annual or semiannual painting.

Another advantage is reduced weight fluctuation. The previously used wooden pen boards, for example, weighed 8 lb when dry and about 14½ lb when wet. Comparable aluminum pen boards have a constant weight of 5.4 lb.

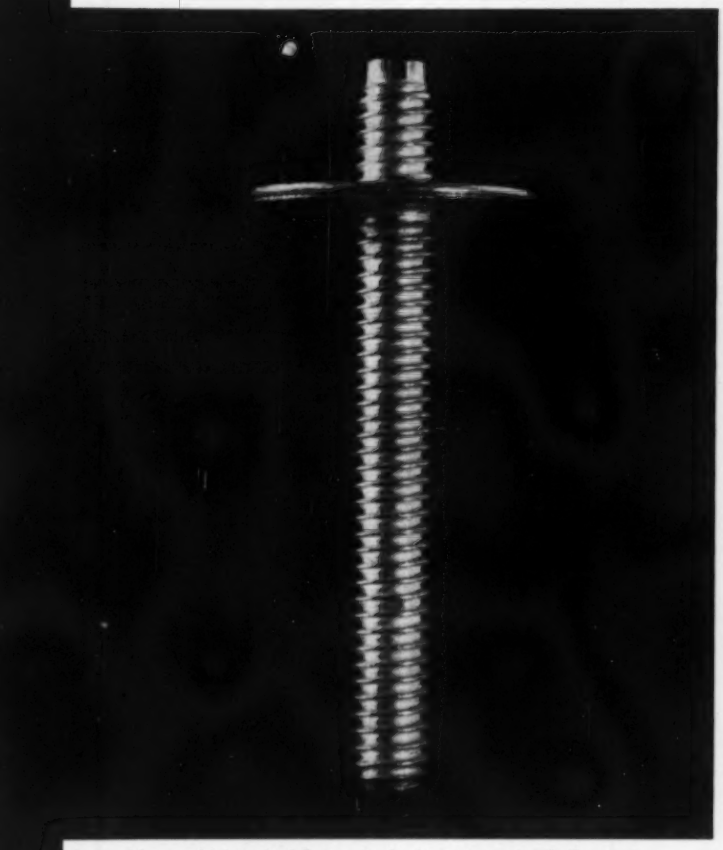
Aluminum alloy 5082 was selected



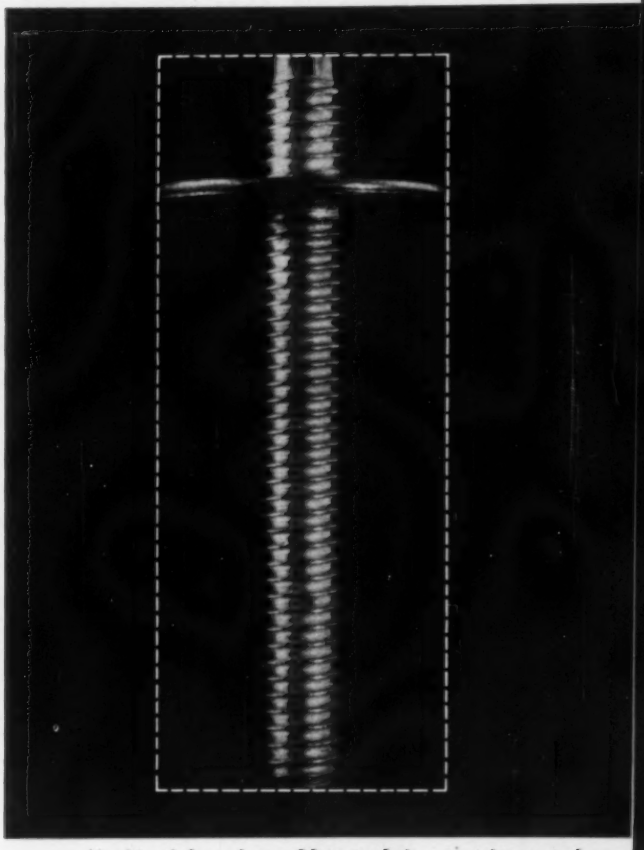
Aluminum hold linings.

Aluminum pen boards.

This "impossible" screw is now being cold-headed



Now cold-headed from steel wire at one-tenth the cost.



Machined from bars, 91 pct of the steel is wasted.

This automobile window-adjusting channel screw is being produced from cold-heading wire at one-tenth the original cost. Formerly machined from bar stock with a 91 per cent waste, this special screw is upset to three-and-one-half times the diameter of its shaft.

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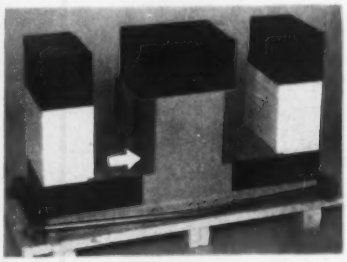
for the linings because of its good resistance to corrosive attack by sea water and its high strength and dent resistance.



***Welding transformer** uses glass-polyester insulation at corners.*

Reinforced Plastic Insulates Transformer

Glass-reinforced polyester channel stock is now being used to insulate the four corners of dry-type transformers used for welding (see accompanying photo).

According to Glastic Corp., reinforced plastics was selected to replace previously used roll-formed fibre because it provides greater mechanical and dielectric strength and better resistance to moisture absorption.

According to Glastic, although reinforced plastics costs about one dollar more per transformer than the fibre, it eliminates the cost of roll-forming fibre and dismantling and reassembling transformers with torn fibre. In addition, there are no rejects. The result, according to Glastic, "is a better product at the same cost."

The transformers, rated from 10 kva to 750 kva, are built by Precision Welder & Machine Co.

Polyester Dye Tanks Eliminate Leaks

After literally centuries of use, wood is being entirely replaced by molded plastics for tanks used in the chemical dyestuffs industry, according to Althouse Chemical Co.

The polyester tanks are lighter, longer lasting and cheaper (actually,

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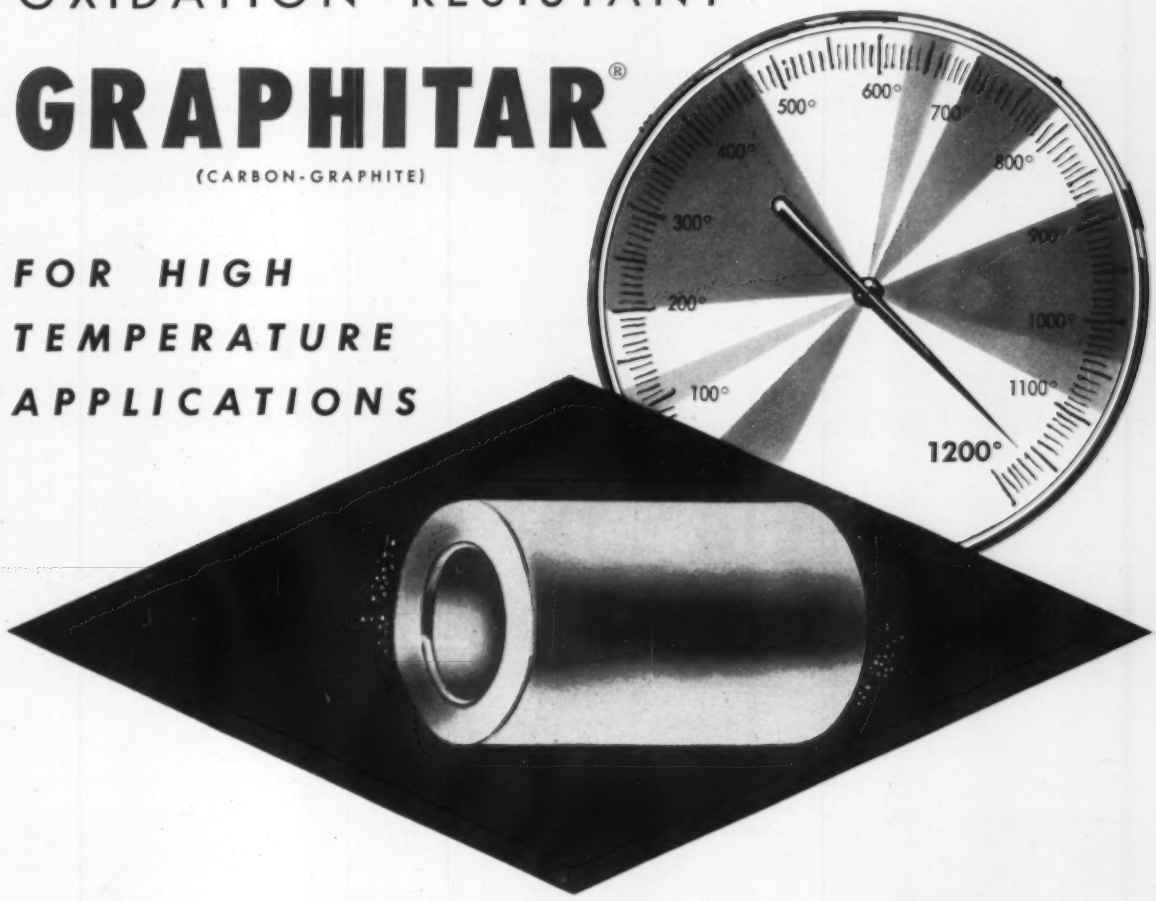
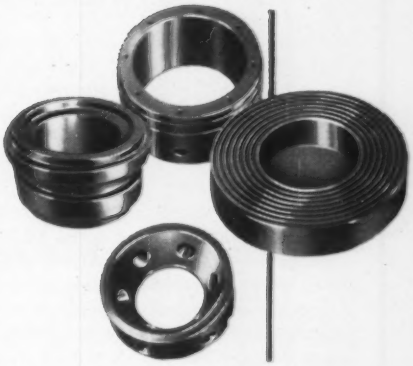


Culminating five years of intensive research, engineers of The United States Graphite Company have developed a new oxidation resistant GRAPHITAR. In exhaustive tests, GRAPHITAR parts were exposed in an oxidizing atmosphere (air) at 1200 degrees F and after 200 hours, the GRAPHITAR showed a weight loss of less than six percent!

GRAPHITAR, which is available in many grades, is a versatile engineering material with unusual and outstanding properties that make it ideal for tough applications. It is non-metallic, resists chemical attack, has self-lubricating properties and a low coefficient of friction. It is mechanically strong, lighter than magnesium and is the perfect material for packing rings, pressure joint seals, clutch release bearings, fluid coupling seals, piston rings, pump liners and vanes.

For more information on this new oxidation resistant GRAPHITAR and its applications, write the GRAPHITAR product manager on your company letterhead.



R-279-1

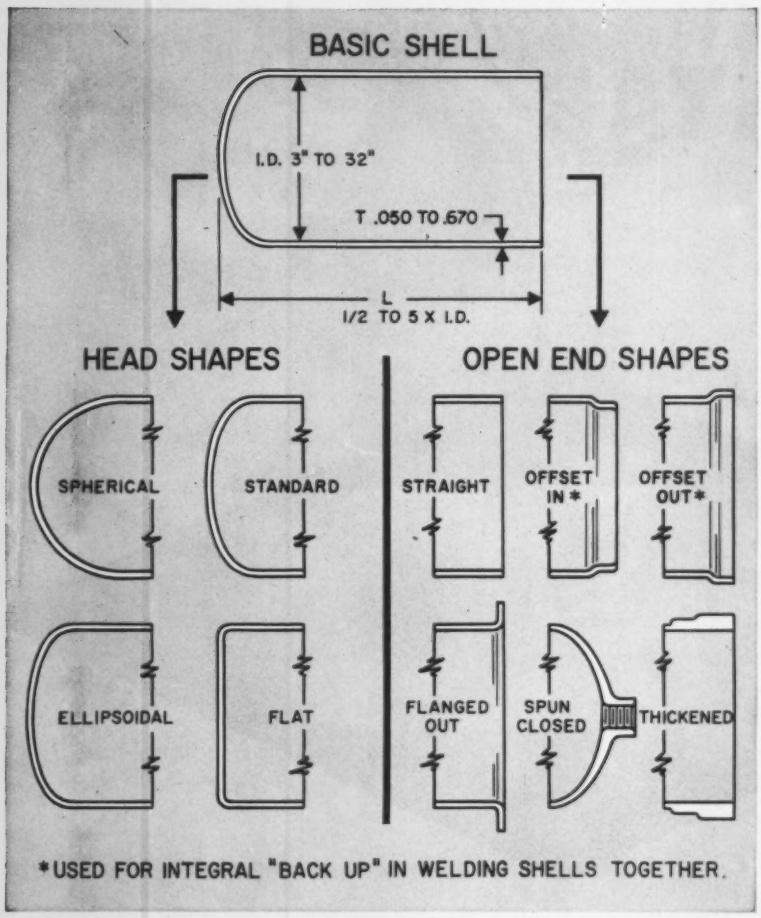
THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 3, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

For more information, turn to Reader Service card, circle No. 382

Your ideas...our methods...give you reliable components at low cost



The drawings shown here give you a simple description of the way you can use basic Hackney shells to produce a variety of seamless, lightweight, strong, low-cost rocket motor cases, gas generator housings, control actuator pressure vessels and other missile components.

The basic unit is a cold drawn, deep shell which has uniform wall thickness from top to bottom in ranges from .050″ to .670″. I.D.'s vary from 3″ to 32″. The length of the shell may be from ½ to 5 times the diameter—or up to 110″.

Head shapes—spherical, standard, ellipsoidal, flat or special. *Open end shapes* offer variety—straight cut, offset in, offset out, flanged out, flanged in, spun closed or thickened. *Capacities* begin at 1 quart—go as large as 100 gallons. *Working pressures* range from 100 to 6000 psi, depending upon diameter and wall thickness.

For full details of our facilities and our methods of making components, write to the address below.

Pressed Steel Tank Company

Manufacturer of Hackney Products Since 1902

1442 S. 66th Street, Milwaukee 14, Wisconsin

Branch offices in principal cities

Hackney

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

For more information, turn to Reader Service card, circle No. 473

they cost more initially, but last three times as long as the wooden tanks).

In addition, the plastics tanks eliminate the four major problems inherent in the use of wood: 1) contamination, 2) leaks, 3) difficulty of cleaning, and 4) tendency to shrink. Stainless tanks were considered, but were too expensive.

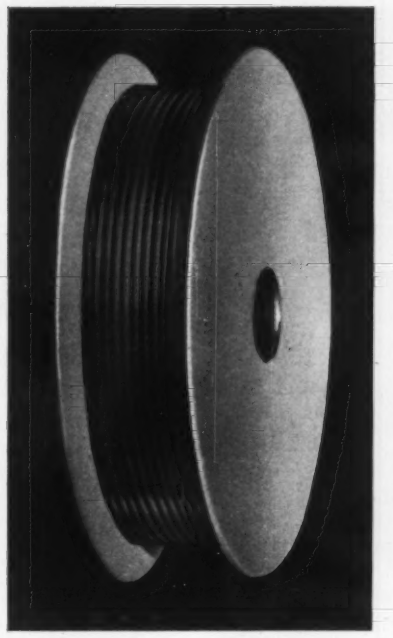
Synthetic Sapphire Rod Used in Wave Tubes

Single crystal synthetic sapphire rod is now being used to support helices in new traveling wave tubes.

The tubes, developed at Stanford University's Electronics Research Laboratory, range in size from slightly larger than the diameter of a pencil lead to over a yard long. Synthetic sapphire was selected because it offers excellent flexural strength at elevated temperatures, porosity, low-loss characteristics, and excellent dielectric properties, zero porosity, low-loss characteristics, and economy.

The sapphire rods, produced by Linde Co., a division of Union Carbide Corp., are available in lengths up to 48 in. and in diameters from 0.010 in.

***Supporting rods** of synthetic sapphire add to performance of new wave tubes.*



Save with WOLVERINE Level-Wound Coils

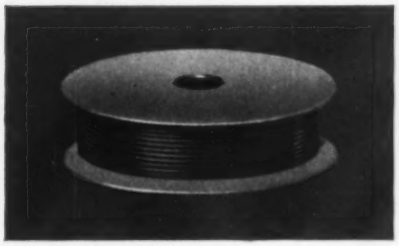
WOLVERINE LEVEL-WOUND COILS
are ideal for feeding automatic equipment — often release operators for other duties.

WOLVERINE LEVEL-WOUND COILS
permit tubing to unwind at high speeds without danger of tangling or snarling.

WOLVERINE LEVEL-WOUND COILS
reduce tube handling—save time in assembly line operations.

WOLVERINE LEVEL-WOUND COILS
permit you to stock more tube in less space —help reduce inventory problems.

WOLVERINE LEVEL-WOUND COILS
contain tubing made the Tubemanship-way—quality controlled tubing that is backed by research, years of experience and sound engineering.



Your Wolverine sales representative has the complete story. Why not talk it over with him—let him show you exactly how Wolverine level-wound coils can fit into your manufacturing process to save you time, money and labor. Write, too for your copy of the Wolverine Tubemanship Book.

CALUMET & HECLA, INC.
CALUMET DIVISION
URANIUM DIVISION
GOODMAN LUMBER DIVISION
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In Canada:
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Manufacturers of Quality Controlled Tubing and Extruded Aluminum Shapes

J-8367

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For more information, turn to Reader Service card, circle No. 368

HIGH DENSITY
POLYETHYLENE
PROFIT PARADE

GUARANTEED 100% "HIGH DENSITY" polyethylene

Fishing Tackle Maker Gets a New Angle on Plastics

Many manufacturers are now looking to Grex high density polyethylene for new products and new profits. One such company is B. F. Gladding Co., Inc., manufacturers of quality fishing lines since 1816. Gladding's choice of the Grace plastic for a new line of tackle boxes marks a major innovation in the company's products.

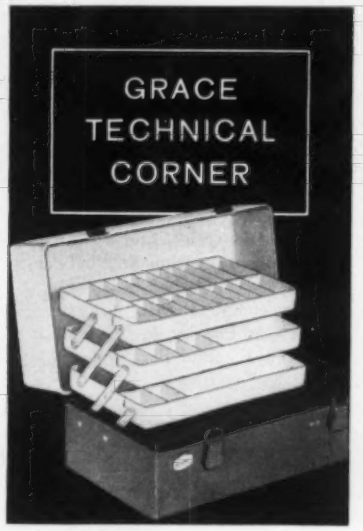
To Gladding, high density polyethylene has proved to be a truly remarkable material. The Gladding Grex Tackle Boxes are tough and rigid—withstand the roughest treatment without breaking, shattering, cracking or denting. Drop one in the water, and it floats. Spill battery acid, oil, gasoline, bug repellents or silicones on the box. Such chemicals—normally harmful to other materials—wipe clean from Grex without staining, softening or marring the finish. Changes in temperature or weather will not cause warpage. Salt water will not corrode. These new boxes will still look new even after seasons of rugged use.

What more could a fisherman want? Or for that matter, what more could you want in a high grade plastic that can be economically fabricated to keep manufacturing costs down and profits up? Find out more about high density polyethylene by calling in the experts. Grace has the production facilities, technical service and experience to help put your product in the Grex profit parade. Everyone says we're easy to do business with.

Grex is the trademark for W. R. Grace & Co.'s Polyolefins.

W.R. GRACE & CO.
POLYMER CHEMICALS DIVISION
CLIFTON, NEW JERSEY

For more information, turn to Reader Service card, circle No. 467



Can high density polyethylene be used in existing molds?

Of the seven molds used to produce Gladding's tackle boxes, six were originally built for a material other than high density polyethylene. Modifications were required in cooling and gating.

Proper cooling. When designing molds for high density polyethylene a prime consideration is to obtain as small a temperature gradient as possible across the face of the mold. In this case, additional channels were cut into the molds, flow of existing channels was changed and bubblers were put opposite each gate. These modifications served to bring the coldest water closest to the hottest material for more uniform cooling.

Conversion to multi-gating. The molds as originally built utilized a single direct sprue gate. This system was changed to multi-gating by the use of a hot runner which provided better control over material temperature. With smaller sprues, the need for three-plate mold construction was eliminated and valuable daylight was saved for easier removal of parts.

As a general rule, proper cooling and gating of molds for high density polyethylene can pay off on four counts: (1) control of warpage and shrinkage, (2) faster cycles, (3) reduction in induced stresses and strains, (4) greater uniformity in density of molded parts.

Do we know all the answers? We have the experience with high density polyethylene on our side—and are learning more every day. Grace has solved problems involving all types of molding, from toys weighing a few ounces to pieces of three and four pounds. Our Clifton Laboratories are equipped to handle almost any molding job. We sincerely want to place our experience and facilities at your command. If you have an application for high density polyethylene, now's the time to contact:

Technical Service Department
W. R. Grace & Co., Clifton, N.J.

News OF INDUSTRY

Literature Searching Service to Cover All Phases of Metallurgy

A special literature searching service, utilizing an electronic computer-type machine capable of searching through 100,000 titles per hour, has been launched by the American Society for Metals.

The new service, to be known as the ASM Metals Documentation Service, is expected to "save thousands of dollars for those needing specific information on metallurgical problems." According to Allan Ray Putnam, ASM managing director, the service will supply subscribers with information on any aspect of metallurgy.

Purpose of the service will be to provide a selecting, abstracting, indexing and searching service that is fast, current and thorough. It will cover all published information on metal production processes, fabrication methods, properties and applications, equipment and fuels, and pertinent refractories.

For further information, contact American Society for Metals, Metals Park, Novelty, Ohio.

Refractory Metals

A study is now underway to develop basic parameters for the fabricability of refractory alloys (molybdenum, tungsten, columbium and tantalum).

The research is being conducted by Harvey Aluminum under contract from Wright Air Development Center, and is being carried out at WADC's metals processing laboratories. Thus far, about 20 unalloyed molybdenum billets and about 30 molybdenum alloy billets have been successfully extruded.

Welding Exposition Set for Apr 25-29

The 1960 Annual Convention and Welding Exposition has been scheduled by the American Welding Society for Apr 25-29 at the Biltmore Hotel and Great Western Exhibit Center, Los Angeles.

The technical meeting, sponsored by AWS and the American Society of Mechanical Engineers, will cover: heat effects on steel weldments, resistance welding, fracture mechanics, aluminum alloys, welding and fabricating Ni-Cr-Fe alloys, nonmetallic structural materials, ductility of steels, brazing, and columbium, titanium and zirconium.

Powder Metallurgists Form New Institute

Individual metallurgists, engineers, researchers, technicians, and others interested in powder metallurgy can now become members of the American Powder Metallurgy Institute.

The Institute, a technology division of the Metal Powder Industries Federation, was previously restricted to corporate membership. The change in policy was dictated by "the growing interest in powder metallurgy and a corresponding increase in the number of individuals involved in the application of this technique."

Functions of the Institute are: 1) to promote investigations, research and interchange of ideas among its members; 2) to promote education in the science, practice and application of powder metallurgy and related arts; and 3) to arrange for the collection and dissemination of information pertaining to powder metallurgy and

"Who's best for
ON TIME
deliveries
of short
run
stampings?"

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SHORT RUN STAMPINGS

3 PLANTS To Serve You Better

Freddy Federal says: "Fast production and on-time stamping deliveries are our specialty. Every job is speedily handled, whether a limited prototype . . . a small pilot run . . . or 10,000 or more pieces. You receive all the benefits of streamlined tooling and work flow methods in our modern one-stop plants . . . plus skilled and experienced craftsmen who are personally interested in meeting your stamping requirements. Send us your part or print today for a prompt, money-saving quotation. Time real short? Just ask for a reply by wire or phone! It's another Federal service to give you stamping deliveries on time!"

Write for illustrated Catalog No. 301 with its many stamping design tips!

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No. Hollywood, California

For more information, turn to Reader Service card, circle No. 330

News OF INDUSTRY

related industries, and for the presentation, discussion and publication of papers and other contributions.

For complete information, write American Powder Metallurgy Institute, 60 E. 42nd St., New York 17.

SAMPE Committee Votes Nationalization

A special steering committee has voted that the Society of Aircraft Materials & Process Engineers (SAMPE) become a national, incorporated organization.

Also proposed at the meeting was a change in the Society's name to the Society of Aerospace Materials & Process Engineers. Final acceptance requires approval by six of the Society's nine operating chapters.

In recent months there has been considerable discussion on whether or not SAMPE should broaden its scope to cover materials men in all industries. The recommendation of the steering committee to simply substitute the word "Aerospace" for "Aircraft" indicates that, at least for the present, broadening the scope of the society is not contemplated.

The significance of the society and its activities was discussed in M/DE in July '59 (p 212) and Oct '59 (pp 249-250).

Engineers

Thomas P. Murphy has been appointed development manager, Fiberfil, Inc.

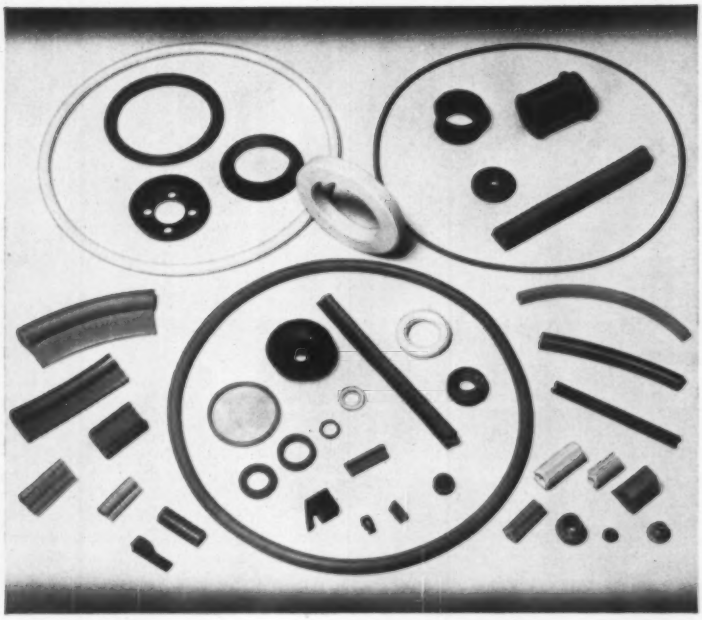
Dr. Augustus B. Kinzel, Union Carbide Corp., has been named chairman, Div. of Engineering and Industrial Research, National Academy of Sciences—National Research Council.

Charles A. Bogenrief has been elected vice president, manufacturing, Robertshaw-Fulton Controls Co.

Jack Katzen has been appointed manager of engineering administration and integration, and **Otto Klima** has been named manager of a systems engineering operation, Missile and Space Vehicle Dept., General Electric Co.

(more News on p 144)

RUBBER
in Design
Engineering



FITTING THE MATERIAL TO THE APPLICATION

No two rubbers are alike. Be sure that, when you design a rubber part, you specify precisely the type of rubber needed for the job involved. Garlock will be glad to offer help, having had years of experience in the engineering and production of molded and extruded, die-cut, and metal bonded parts:

Natural Rubber—used where high tensile strength and resiliency are required. Good air-aging properties. Resists dilute aqueous solutions. Applications include automotive air springs, shock mounts, tubing.

Styrene Butadiene Rubber—used where resistance to aging is important. Good abrasion, water resistance. Readily available, low cost. Applications include weather stripping, pipe joint gaskets, bushings and grommets.

Nitrile Rubber—extremely good oil and gas resistance . . . low solubility, low swelling, good tensile strength, excellent abrasion resistance. Used up to +250° F as oil seals, "O" Ring packing, oil resistant parts.

Neoprene Rubber—relatively unaffected by oxidation, weathering, ozone, sunlight, chemicals. Good resistance to abrasion, cutting, chipping. Applications include bridge pads, flexible couplings, spark plug boots.

Butyl Rubber—outstanding impermeability to gases, excellent dielectric properties, good resistance to tearing after aging. Unaffected by weather, ozone. Used as hydraulic seals, vibration mountings.

Garlock also offers a complete line of specialty rubbers to resist the higher temperatures and more reactive fluids introduced by modern industry and the jet age.

GARLOCK

Further information may be obtained from your Garlock representative at the nearest of Garlock's 26 sales offices throughout the U.S. and Canada. Or, write for Catalog AD-167, The Garlock Packing Company, Palmyra, N. Y.

Canadian Div.: The Garlock Packing Company of Canada Ltd.

Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . . two thousand different styles of Packings, Gaskets, Seals, Molded & Extruded Rubber, Plastic Products

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BERYLLIUM is available now. It is being used in increasing quantities for aircraft/missile, nuclear and instrument applications.

With 25 years experience in producing beryllium copper alloy mill products, The Beryllium Corporation now offers fabricated beryllium metal.

Our experienced research and sales engineering departments invite inquiries for production or development interest in *beryllium*. Write for information or assistance. Our engineers will gladly work with you.

BERYLCO®

THE BERYLLIUM CORPORATION

P.O. Box 1462, Reading, Pennsylvania

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News OF INDUSTRY

J. Alfred Earl has been named chief ceramics engineer, Technical Industries Corp., Pasadena, Calif.

J. R. Madigan has been appointed senior scientist, Roy C. Ingersoll Research Center, Borg-Warner Corp.

Irving P. Magasiny has been named director of engineering, Schaevitz Engineering, Pennsauken, N. J.

David G. Green has been appointed chief engineer, Triangle Mfg. Co.

Arthur Adler has been named director of research, Micronized Metals, Inc.

Leonard R. Sainsbury has been elected vice president and technical director, Peerless Photo Products, Inc.

Richard P. Simmons has been named manager of quality control, Latrobe Steel Co.

Robert G. Vance has been named chief development engineer, Elwell-Parker Electric Co.

John Gronan is now chief project engineer, Nuclear Power Engineering Dept., Alco Products, Inc.

Edward L. Roth, Motor Castings Co., has received the Gray Iron Founders' Society Gold Medal Award for his "multitude of effectual contributions and services to the Society and to industry."

James Henderson has been appointed plant superintendent, Chester Cable Corp.

James G. Weldon has been appointed manager, Hydraulic Dept., Bendix-Pacific Div., Bendix Aviation Corp.

Edwin M. Hinsdale has been named chief engineer, Communications Products Dept., Radio Corp. of America.

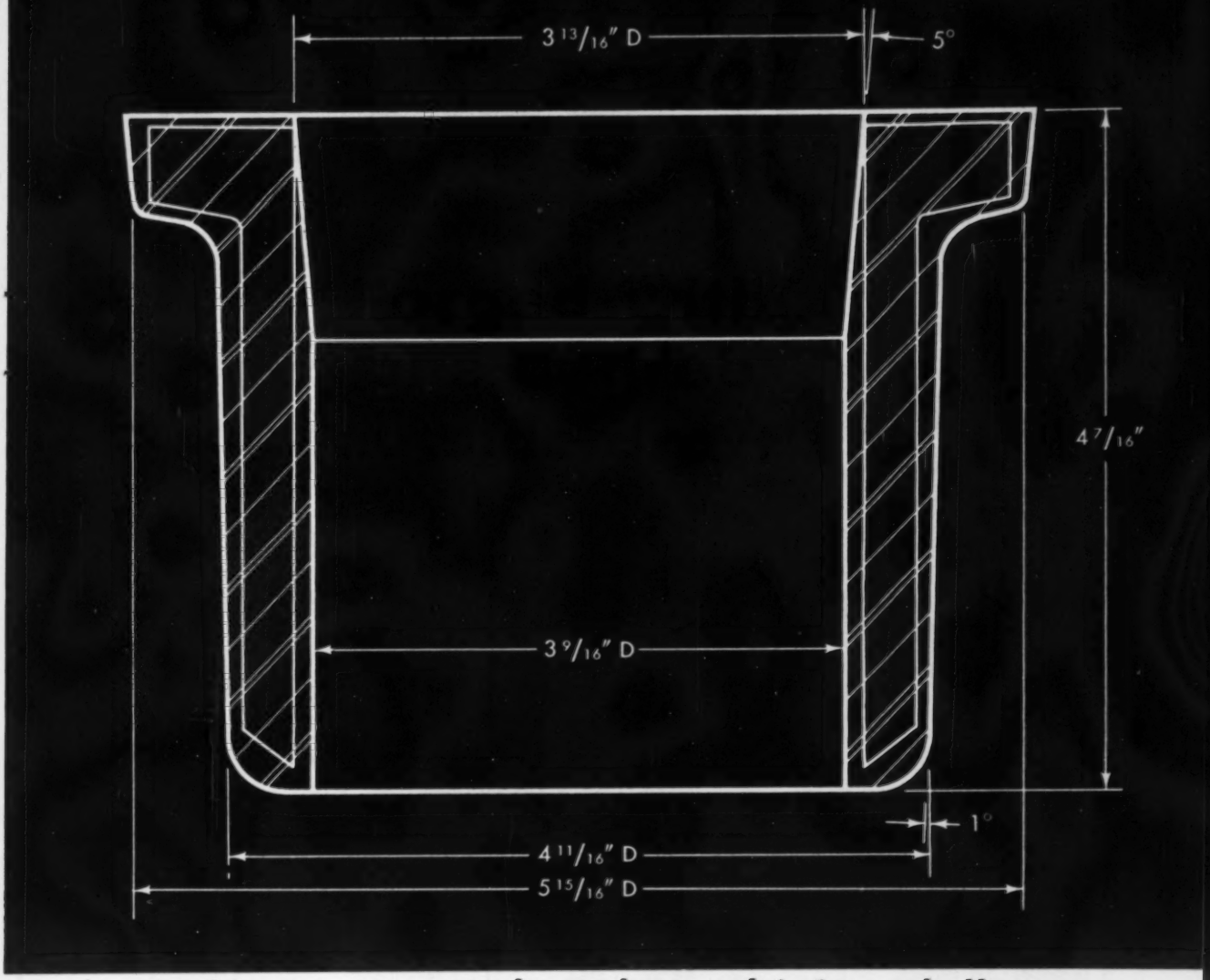
Dr. R. H. Fritts has been named manager, thermoelectric project, Minnesota Mining & Mfg. Co.

Carl B. Fryklund has been appointed supervisor, regional applications engineering, Semiconductor Div., Raytheon Co.

Dr. Heinz Schulze has been named to the research staff of Jefferson Chemical Co.'s Austin Laboratories.

G. A. Eagleton and **H. H. Gnuse, Jr.** have been appointed assistant chief power engineer, Power Engineering Div., Aluminum Co. of America.

Edward J. Dulis has been appointed to the newly created position of manager of product research, Re-



...to save metal and machining dollars

Forging with minimum external and internal drafts is a Bethlehem specialty. Witness the closure hub above.

We forge this part and others like it in a mechanical press to 1 degree outside draft, 5 degree inside draft. Then we hot-broach the inside draft to facilitate internal chucking. By the time this hub arrives at our customer's machine shop, little machining is required. Machining's a lot safer, easier, and faster, too. Because of the small drafts, chuck jaws can get a big bite on the part. They won't slip. Our customer can safely use higher horsepower machine tools, and speed his work.

Because we're able to forge to 1 degree drafts *or less*, the weight of the product can be reduced. That saves metal as well as machining dollars. We'd like to pass on similar savings to you. Call or write our nearest sales office today.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

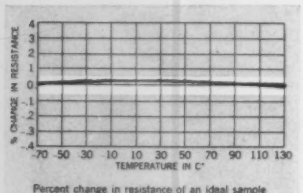
For more information, turn to Reader Service card, circle No. 369

— the time-tested standard of the resistor industry

Evanohm*

RESISTANCE ALLOY

— for resistors and precision instruments



Percent change in resistance of an ideal sample of Evanohm. Normal production material (.002" and finer) is supplied within the range ±10 ppm (-65° to 25°C. and 25° to 125°C. referred to 25°C.).

Wherever exceptional stability over a wide temperature range is essential, EVANOHM is the accepted standard of performance. This high-reliability resistance alloy provides high specific resistance, low temperature coefficient, low thermal EMF to copper. EVANOHM is especially recommended for use in resistors, aircraft instruments, for guided missiles, rockets and other precision equipment. Available in bare wire, enamel, formvar, polyurethane, silk, cotton, nylon and glass insulation. Write for complete electrical and mechanical data and recommendations on your specific application.

**Patents 2,293,878-2,638,425 — Tradename Registered*

WILBUR B. DRIVER CO.

Main Office: NEWARK, N. J. — Tel. HUmboldt 2-5550

Branch Offices and Warehouses in Principal Cities. Manufacturing Plants: 1875 McCarter H'way, Newark 4, N. J.; 2734 Industrial Way, Santa Maria, Calif. Canadian Wilbur B. Driver Co., Ltd., Rexdale (Toronto). Subsidiary: Western Gold and Platinum Co., 525 Harbor Blvd., Belmont, Calif.

For more information, turn to Reader Service card, circle No. 360

News OF INDUSTRY

search Laboratory, Crucible Steel Co. of America.

E. A. Zywiec has been named chief engineer, Michigan Seamless Tube Co.

Robert H. Bragg has been named production control manager, Leschen Wire Rope Div., H. K. Porter Co., Inc.

Harold S. Thorpe is now general manager, Avnet Electronics Corp. of Northern California.

John C. Cassidy has been appointed manager of product projects, American Car & Foundry Div., ACF Industries, Inc.

Companies

Sel-Rex Corp. has purchased **Meaker Co.**, which will operate as a wholly-owned subsidiary of Sel-Rex.

Pax Electronic Co. has moved to new quarters at 48-67 58th St., Woodside 77, N. Y.

A. O. Smith Corp.'s Electric Motor Div. has broken ground for a 42,000-sq ft plant addition.

Aluminum Co. of America announces the following recipients of its Alcoa Industrial Design Awards, presented at the annual meeting of the American Society of Industrial Designers: Peter Muller-Munk, Muller-Munk Asso.; F. W. Priess, Montgomery Ward & Co.; and Charles Eames, Herman Miller Furniture Co.

Midland-Ross Corp. has purchased **Surface Combustion Corp.**, including Surface Combustion's Janitrol Aircraft Div.

Chromalloy Corp. has acquired **Sintercast Corp. of America.**

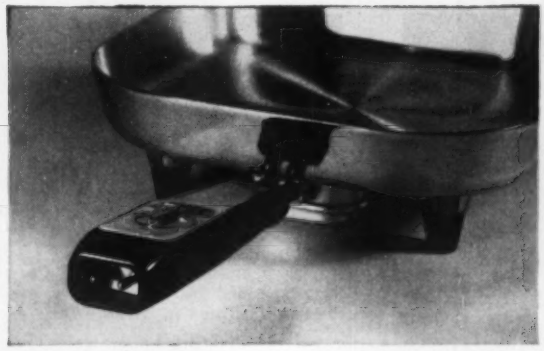
Corning Glass Works has formed a new Ceramic Department for production of ceramic parts primarily for the electronics industry.

Filon Plastics Corp. has opened new national headquarters and manufacturing facilities at 333 N. Van Ness Ave., Hawthorne, Calif.

Linde Co., a division of Union Carbide Corp., has begun production in its new liquid hydrogen plant at Tonawanda, N. Y.

Consolidated Vacuum Corp. is the new name for Rochester Div., **Consolidated Electrodynamics Corp.**

United Aircraft Corp.'s Norden Div. will construct a new multi-million-dollar office, manufacturing and re-

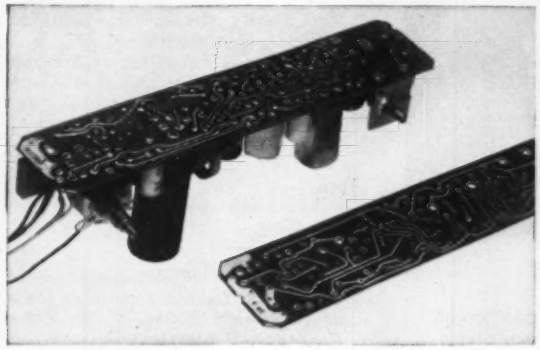


1 The handle of this automatic fry pan is molded of phenolic to:
(a) stay cool *(b) fit small hands*
(c) insulate inner wiring

2 In 18 years, it's been re-coated with phenolic paints:
(a) 2 times *(b) 5 times*
(c) 9 times

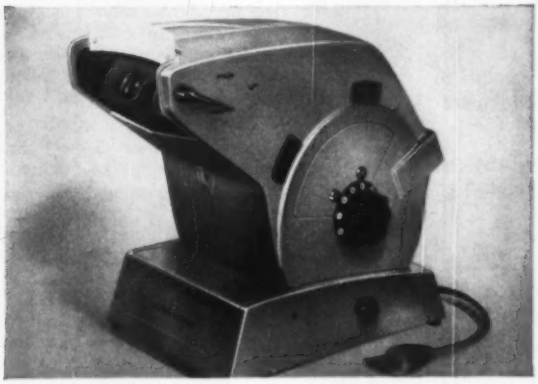
Can you pass this test on Phenolic Plastics?

(You'll discover more of their potential as design materials)



3 This modern electronic circuit is *printed* on a base of:
(a) molded phenolic *(b) phenolic-impregnated paper laminate*
(c) phenolic-coated metal

4 These smoother-finished metal castings result from:
(a) phenolic-bonded shell molds *(b) phenolic-based coatings*
(c) phenolic-bonded grinding wheels



5 This device to test vision has a molded phenolic case that:
(a) cuts weight 50% *(b) needs 25% less tooling*
(c) requires no coating

ANSWERS... *to design and production problems throughout industry are found in dependable BAKELITE phenolic plastics.*

1. Check (a) and (c), and add durability.
2. (a) Twice—phenolic paints last 7 years on the San Francisco Bay Bridge.
3. (b) A laminate—machineable, chemically inert, and non-conductive.
4. (a) Lightweight shell molds that virtually eliminate machining.
5. Check (a), (b), and (c)—it saved all around.

If you have questions—about designing with plastics for function, serviceability, economy and appearance—please ask us. We'll be glad to answer on the practical design and engineering uses of vinyls, epoxies, phenolics, styrenes, and polyethylenes. Just write or call any of our offices or write Dept. BV-05D, Union Carbide Plastics Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 7.

UNION CARBIDE

"Bakelite" and "Union Carbide" are registered trade marks of Union Carbide Corporation.

For more information, turn to Reader Service card, circle No. 343

IOCHROME

IOCHROME is a super-pure chromium metal, made by decomposition of chromium iodide. It contains no single metallic or gaseous impurity in quantities greater than 10 parts per million (0.001%).

IOCHROME has displayed a higher degree of ductility compared to other so-called pure chromium metal. The improved ductility was attributed to the high degree of purity.

IOCHROME will be useful in two areas: In the development of high chromium content super-alloys and ductile chromium base alloys.—It is generally accepted that increased chromium content will improve high temperature properties.

IOCHROME makes it possible to add 5 to 10 percent more chromium to certain alloys without impairment of their fabricability or room temperature ductility.

CHROMALLIZING, a process for surface alloying refractory metals, superalloys and even ordinary steels, protects these metals at high temperatures.

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Chromalloy corporation

450 Tarrytown Road • White Plains, New York
WHite Plains 6-0020

CHROMIZING CORPORATION, LOS ANGELES, CALIFORNIA
PROPELLEX CHEMICAL DIVISION, EDWARDSVILLE, ILLINOIS
Propellants, cartridge actuated devices, explosives and special chemicals.
ELYRIA FOUNDRY DIVISION, ELYRIA, OHIO. Quality gray iron castings.
SINTERCAST DIVISION, YONKERS, N. Y. Machinable carbides & nuclear materials.

For more information, turn to Reader Service card, circle No. 344

News OF INDUSTRY

search laboratory building in Norwalk, Conn.

Kaiser Aluminum & Chemical Corp. has expanded its super purity production facilities in Mead, Wash.

Associated Testing Laboratories, Inc. will build a new environmental testing facility in Orlando, Fla.

Regal Plastic Co. has moved to 1725 Holmes St., Kansas City, Mo.

Rheem Mfg. Co. has acquired a majority interest in **Califone Corp.**, which will become **Rheem Califone Corp.**

Aero-Plastics Inc. is the new name for **Western Model Works,** Seattle, Wash.

High Purity Metals, Inc., 340 Hudson St., Hackensack, N. J., is a newly formed subsidiary of Accurate Specialties Co., Inc., which will specialize in the production of high purity raw materials.

Societies

Small Lot Stamping Institute has elected the following officers: president—Richard Boker, V. A. Boker & Sons; vice president—Stan Wochnik, Short Run Stamping Co.; and secretary-treasurer—Melvin Lorentz, HPL Mfg. Co.

American Society of Industrial Designers has elected the following 1959-60 officers: president—Richard S. Latham, Latham, Tyler & Jensen; vice president—Raymond Spilman, New York City; national secretary—Clarence Francis Graser, International Business Machines Corp.; and treasurer—Kenneth Van Dyck, Van Dyck Asso.

Non-Ferrous Founders' Society has elected the following 1959-60 national officers: president—M. E. Nevins, Wisconsin Centrifugal Foundry, Inc.; first vice president—Elmer G. Brumund, Jr., Brumund Foundry Co.; second vice president—Dan A. Mitchell, Progressive Brass Mfg. Co.; secretary-treasurer—Herbert F. Scobie; and assistant secretary-treasurer —Florence M. Guernier.

Society of Plastics Engineers, Inc. has elected the following 1960 national officers: president—George W. Martin, Holyoke Plastics Co.; first vice president—Frank W. Reynolds, International Business Machines Corp.; second vice president—Hai-

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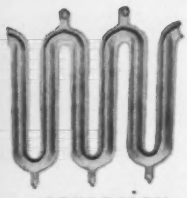

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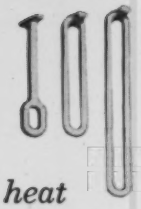

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man S. Nathan, Atlas Plastics, Inc.; secretary—James R. Lampman, General Electric Co.; and treasurer—Joseph B. Schmitt, Koppers Co., Inc.

Meetings

AMERICAN INSTITUTE OF MINING, METALLURGICAL, AND PETROLEUM ENGINEERS, annual meeting. New York City. Feb 14-18.

5TH NATIONAL ELECTRICAL INDUSTRIES SHOW, American Electrical Industries Expositions, Inc. New York City. Mar 6-9.

STEEL FOUNDERS' SOCIETY OF AMERICA, 58th annual meeting. Chicago. Mar 7-8.

SYMPOSIUM ON PROCESSING OF MATERIALS FOR RE-ENTRY STRUCTURES, Society of Aircraft Materials and Process Engineers, Mid-West Chapter. Dayton, Ohio. Mar 9-10.

TEMPERATURE MEASUREMENT SYMPOSIUM, Instrument Society of America. Columbus, Ohio. Mar 9-11.

INSTITUTE OF RADIO ENGINEERS, INC., IRE national convention. New York City. Mar 21-24.

6TH NUCLEAR CONGRESS, Engineers Joint Council in cooperation with Instrument Society of America. New York City. Apr 3-8.

SOUTHWEST METALS & MINERALS CONFERENCE, American Institute of Mining, Metallurgical, and Petroleum Engineers. Los Angeles. Apr 21-22.

1960 POWDER METALLURGY SHOW AND MEETING, Metal Powder Industries Federation. Chicago. Apr 25-27.

AMERICAN WELDING SOCIETY, INC., 41st annual convention and welding exposition. Los Angeles. Apr 25-29.

ELECTROCHEMICAL SOCIETY, spring meeting. Chicago. May 1-5.

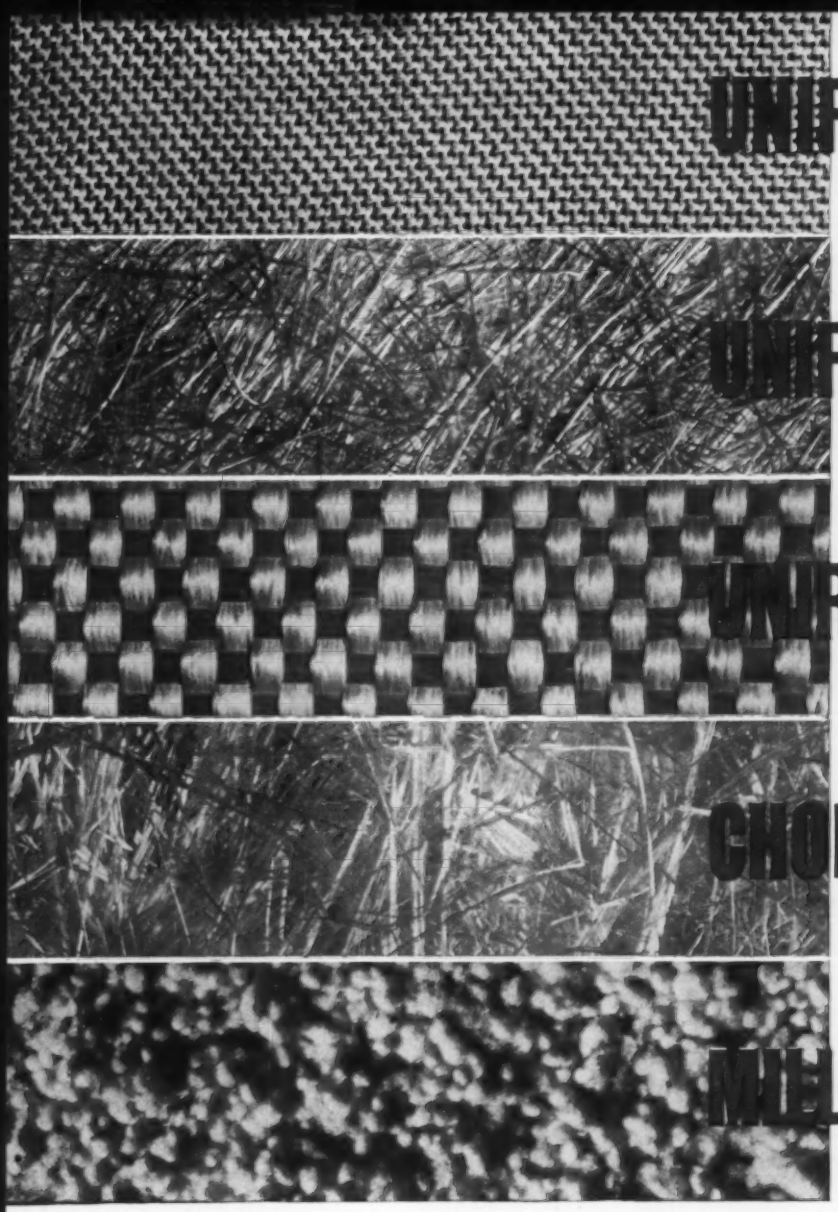
INSTRUMENT SOCIETY OF AMERICA, 3rd national ISA power instrumentation symposium. San Francisco. May 9-11.

2ND SOUTHWESTERN METAL EXPOSITION AND CONGRESS, American Society for Metals. Dallas. May 9-13.

SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS, 1960 national spring meeting. Indianapolis. May 18-20.

DESIGN ENGINEERING CONFERENCE, Machine Design Div., American Society of Mechanical Engineers. New York City. May 23-26.

DESIGN ENGINEERING SHOW, New York City. May 23-26.



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(cont'd from p 102)

How Nuclear Radiation Affects Petroleum, Synthetic Lubricants

What happens to a lubricant when it comes in contact with a nuclear radiation source? H. Gisser of Frankford Arsenal says a lubricant will probably undergo the following changes:

1. Viscosity will decrease at first but will eventually increase.
2. Acidity will increase.
3. Volatility will increase.
4. Foaming tendencies will increase.
5. Coking tendencies will generally increase, but occasionally will decrease.
6. Flash point will decrease.
7. Autogeneous ignition temperature will decrease.
8. Oxidation stability will decrease.

In addition to the above changes in physical and chemical properties, a lubricant will always liberate a gas when exposed to nuclear radiation.

Although some radiation effects are found in lubricants at a dose of 10^7 r, the major effects are observed at doses between 10^8 and 10^9 r, according to Gisser. He says most fluid lubricants are damaged to the extent where they are completely unserviceable at radiation doses beyond 10^9 r.

Information on how radiation affects specific lubricants is summarized below:

Petroleum lubricants—In general, petroleum lubricants are more stable than other lubricants. There is little change at 10^8 r, very little acid is formed, and oxidation stability, as measured by a 72-hr test at 340 F, is only slightly affected.

Esters—Most of the radiation work on synthetic lubricants has been done on the saturated aliphatic diesters such as bis (2-ethylhexyl) sebacate, azelate and adipate. In general, these substances are much more prone to radiation damage than hydrocarbons, according to Gisser.

Fluorinated compounds—Although fluorinated compounds liberate much less acid than esters, they are not promising as radiation resistant lubricants because their acids are much stronger and cause extensive corrosion to metals.

Silicone compounds—Gisser says the behavior of silicon-containing organic compounds in contact with a

Impact test for foams—The device shown here can be used to obtain a quantitative measure of absorbed, transmitted and rebound energy characteristics for plastics and rubber foams and other cushioning materials. The device, called Plasti-Dart No. E-35, was developed by Plas-Tech Equipment Corp., 4 Mercer Rd., Natick, Mass. Impact resistance data is obtained by dropping a dart equipped with removable weights onto a test specimen previously mounted over a transducer. A transducer signal is fed into an oscilloscope and a load-time curve is obtained as an oscilloscope trace. The load-time curve is photographed by means of a Polaroid camera attached to the oscilloscope face.

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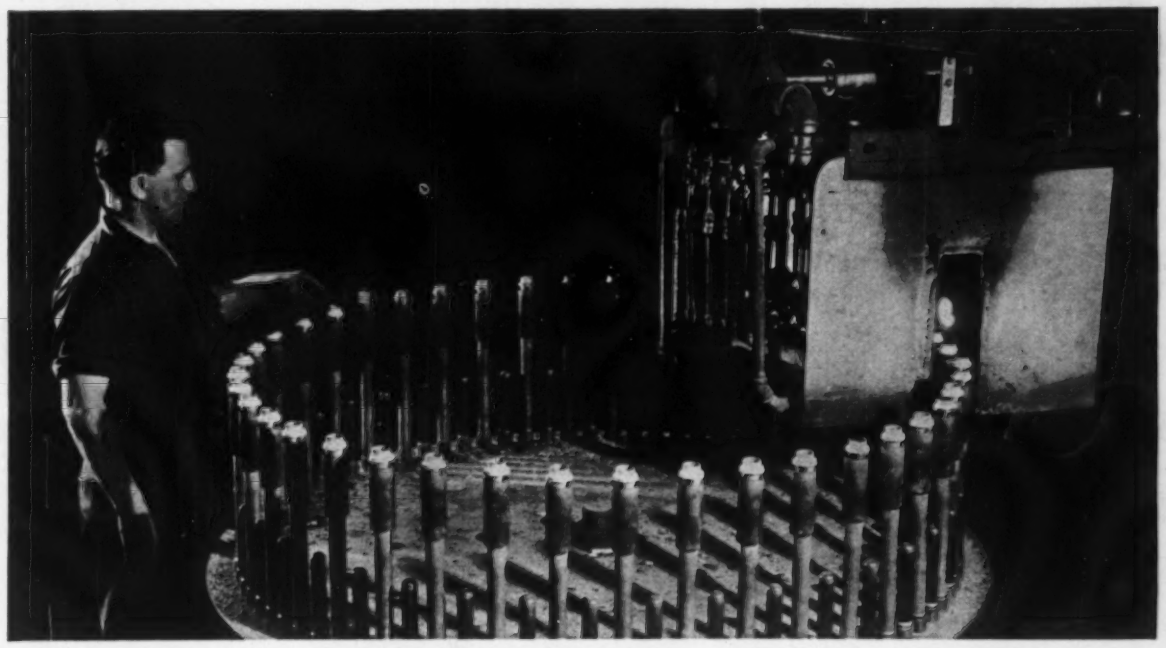
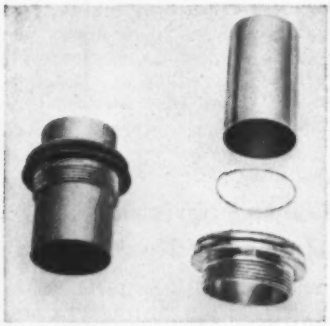


Rotating jig showing mounted assemblies entering and leaving gas-air furnace.



Left– brazed assembly. Right– components with preform ring of EASY-FLO *45.*

This Hartford, Connecticut, company makes—in volume—an assembly that goes into the overflow system of household appliances. The assembly consists of brass tubing and a machined brass casting. The two components are joined by a preplaced ring of Handy & Harman EASY-FLO 45 silver brazing alloy and HANDY FLUX. Heating is automatic gas-air; parts are placed on a rotating turntable to pass through the gas furnace. Every 60 working minutes, 650 assemblies are completed.

The advantages here are that the manufacturer can use thin-walled tubing with heavier, threaded components at no sacrifice in strength. Because of EASY-FLO's penetrating qualities, the entire shear area is fully as strong as the solid parts of the assembly, yet considerably lighter. And, casting and machining the components for this assembly have been greatly simplified.

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nuclear radiation source depends on the structure of the compound. For example, dimethyl siloxanes increase greatly in viscosity, and the higher viscosity grades of the compound gel when exposed to nuclear radiation. Chlorophenyl silicone yields a significantly larger proportion of acids than other silicones. The high molecular weight tetralkylsilanes behave as the aliphatic hydrocarbons. The silicate esters show high viscosity changes when irradiated to 10^8 r.

Aromatic hydrocarbons—Aromatic hydrocarbons change very little when exposed to 10^8 r.

Phosphates — The organic phosphates, which find use as hydraulic fluids, are extremely unstable at radiation doses of 10^8 r. Perhaps the most important change is the formation of large quantities of acid.

Grease—Conventional metal soap-mineral oil greases show extreme sensitivity to radiation. In general, grease softens excessively at radiation dosages of about 10^8 r. Using penetration as a guide, the behavior of greases may be summarized as follows: at first the penetration increases, i.e., the grease becomes softer; as radiation continues the grease becomes harder, eventually solidifying.

Gisser's review on the effects of nuclear radiation on lubricants was given at a recent conference sponsored by the Ordnance Materials Research Office of Watertown Arsenal, Watertown, Mass.

How to Fabricate, Join Acetal Resin

Molded acetal resin parts can be sawed, milled, turned, drilled, reamed, shaped, threaded and tapped easily on standard machine shop equipment, according to W. C. Warriner of Du Pont's Polychemicals Dept., Wilmington, Del. Warriner recently told a group of engineers attending a meeting of the Rubber & Plastics Div. of the American Society of Mechanical Engineers how to fabricate, join and assemble molded acetal parts.

Acetal resin was introduced by Du Pont in late 1956 under the tradename Delrin. Detailed information on its properties and uses was given

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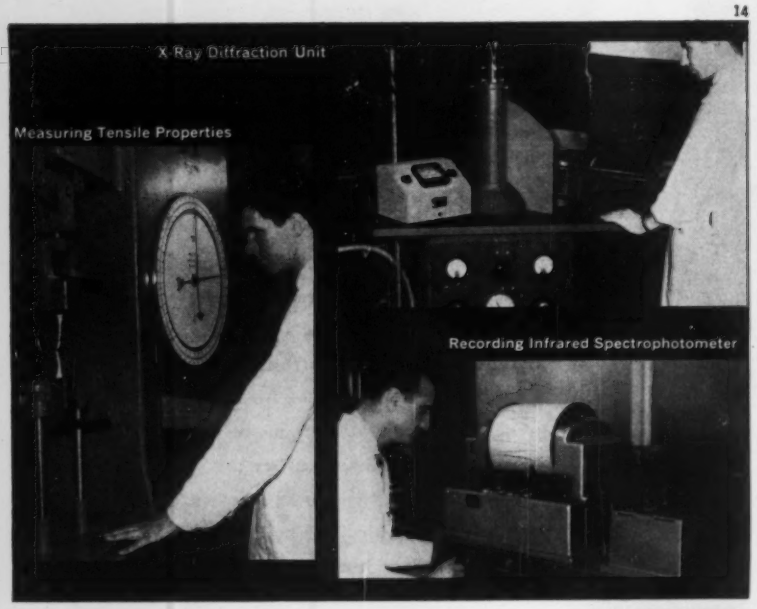
Knowing how to induce failure in the laboratory, and prevent trouble in the field, calls for trained evaluation engineers... engineers who know sound corrective design, too. Why not apply this know-how to your new product. Write or phone for details. No obligation.

14



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in the Feb '57 (p 153) and Jan '58 (p 155) issues of this magazine.

Warriner says no coolant or lubricant is necessary when machining Delrin acetal resin parts at low speeds; however, lubricants are recommended for high speed machining. Other data given by Warriner on the fabrication and joining of Delrin are summarized below:

Welding

Hot plate welding—Warriner says two pieces of Delrin can be joined together by melting them on a hot plate and pressing them together under light pressure.

Hot wire welding—An electrical current passing through a wire placed at the joint between two Delrin pieces melts the adjacent plastics material and joins the two pieces together. Warriner says welds of this type have a shear strength of 750 psi per in. of embedded wire.

Induction welding—Delrin can be induction welded by inserting a metal ring in the joint between two Delrin pieces and placing the joint in an electromagnetic field. This method produces joints with the metal ring completely enclosed in the thermoplastic material.

Spin welding—Joints between two Delrin circular pieces can be made by holding one piece and rotating the other piece against it under slight pressure until frictional heat melts and joins the pieces together. Warriner says this operation is fast and adaptable to production line methods.

Cementing, solvent welding—Lap joints of Delrin using various cements are not too satisfactory. Solvent welding to date has not proved attractive since Delrin is not dissolved by any of the common solvents at room temperature.

Fastening

Self-tapping screws — Delrin accepts and permanently holds self-tapping screws.

Press fitting—Delrin can be joined to itself and to other materials by press fitting. For example, a steel shaft can be pressed into a Delrin gear with good results.

Snap fitting—Two Delrin parts can be snap-fitted together by molding a slight undercut in one part

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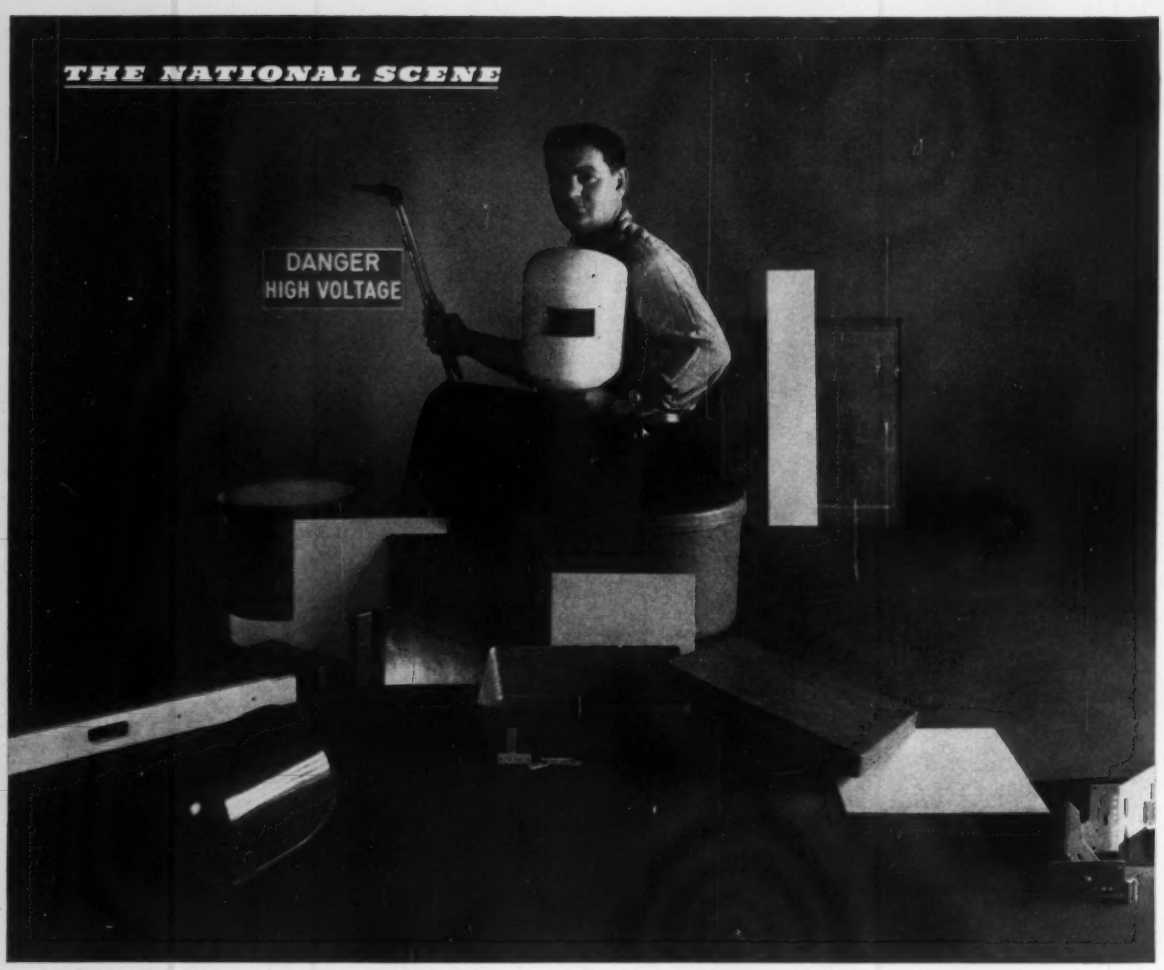

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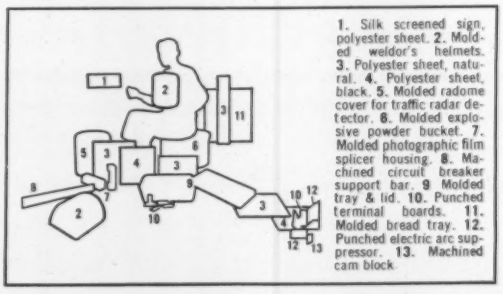
One more point. The problems inherent in machining polyester glass laminates have had a tendency to discourage some designers from considering it. We suggest that you bounce this headache out of your production facilities and into ours.

You see, we are interested in *both* your design and machining problems. Your component will be skillfully machined at one of our four complete, "service-located" fabricating facilities.

Send for our Polyester Technical Bulletin 1164. We'll be happy to include, also, data on the full line of National materials—over 100 grades. Write to National Vulcanized Fibre Co., Dept. KK-2, Wilmington 99, Delaware.



1. Silk screened sign, polyester sheet. 2. Molded weldor's helmets. 3. Polyester sheet, natural. 4. Polyester sheet, black. 5. Molded radome cover for traffic radar detector. 6. Molded explosive powder bucket. 7. Molded photographic film splicer housing. 8. Machined circuit breaker support bar. 9 Molded tray & lid. 10. Punched terminal boards. 11. Molded bread tray. 12. Punched electric arc suppressor. 13. Machined cam block.

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ENGINEERING & DESIGN

with a matching projection on the other part. The two assembled parts deform temporarily until the undercut and the projection match, whereupon they snap into a mating position.

Finishing

Buffing, polishing—Rough finishing of Delrin can be accomplished by power driven rotary steel burrs and abrasive disks. The thermoplastic can be wet sanded on a belt or disk sander.

Painting—Delrin can be painted successfully with acrylic and other types of paint.

Annealing

Warriner says Delrin, like metals, will retain some internal stresses after molding or extruding. Sometimes it is desirable to relieve these stresses, especially when good dimensional stability or good abrasion resistance is required. Stress relieving can be accomplished by immersing the part in a heated oil bath. A bath temperature of 320 F is recommended for parts 1 in. thick or less. Immersion time varies from 5 min for ⅛-in. thick parts to 30 min for 1-in. thick parts. A bath temperature of 300 F is recommended for parts thicker than 1 in. Immersion time is 1 hr per in. of cross-sectional thickness.

Annealed pieces should be removed from the bath and cooled to room temperature in a draft-free container. Accelerated cooling is not desirable because of the possibility of reintroducing stresses into the stress-relieved Delrin part.

Some Plastics Can Corrode Metal Parts

Service experience and laboratory tests show that some plastics and rubbers can corrode metal parts exposed to humid environments. The materials release electrolytes which are dissolved in water present on the surface of metal parts.

Case histories on the corrosivities of plastics and rubber are given in a recent report prepared by H. A. Perry, Jr., A. M. Chreitzberg, I. Silver and H. E. Mathews of the U. S. Naval Ordnance Laboratory, White Oak, Md. The report, No. PB 151750, is available from the Office of Tech-

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2. Unique rolling mill for strip from .001" down, makes possible extremely close control of the final pre-anneal temper, and uniform accuracy of the final temper.

NEARLY FIFTY YEARS

3. Experience exclusively with thin strip metals gives Somers an unmatched background in engineering *ultra-thin* strip to meet all special requirements.

FOR EXACTING STANDARDS ONLY

Somers

Somers Brass Company, Inc.
108 BALDWIN AVE., WATERBURY, CONN.

For more information, circle No. 404

Chace Thermostatic Bimetal

ACTUATES ANOTHER PRECISION PRODUCT

THE

AMERICAN-Standard PRODUCTS

THERMOSTAT

A PRODUCT OF AMERICAN-STANDARD
DETROIT CONTROLS DIVISION, DETROIT, MICHIGAN

This new thermostat, No. CA 520, a product of American-Standard, Detroit Controls Division, offers the ultimate in style, comfort and dependability. It was designed and manufactured especially for use with American-Standard Furnaces, the "one responsibility" concept. Its features include: hermetically sealed mercury switch; soldered circuit joints and flexible wire; clear plastic base plate for fast installation; five-degree dial calibration and wider selection of temperatures (50° to 90°); and attractive decorator design with concave rim and cover, in bronze and silver, (or paint it yourself). Both the actuating element and the temperature indicating element are Chace Thermostatic Bimetal.

Perhaps sensitivity (or lack of it) is the one feature of a room thermostat most likely to impress the homeowner. One wants to be unconscious of a heating system, not reminded by frequent periods of chill or overheating. The extreme sensitivity and unfailing reliability of Chace Bimetal are the result of Chace's third-of-a-century devoted to the development of efficient alloys and bimetal combinations, plus manufacturing methods and equipment devoted exclusively to the production of precision thermostatic bimetal. Discriminating bimetal buyers can always be certain that their names on the "outside" are safe with Chace "inside."

Chace Thermostatic Bimetal is available in strips, coils and completely fabricated elements of customers' designs — and in more than 30 types. If you have a product in the "thinking stage," send for our booklet, "Successful Applications of Chace Thermostatic Bimetal," for its many pages of illustrated temperature-actuated devices plus much valuable engineering data.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

For more information, turn to Reader Service card, circle No. 428

nical Services, Dept. of Commerce, Washington 25, D. C. It sells for $1.25.

Data from the report are summarized below:

Phenolic resins—Service experience shows that the most corrosive plastics are phenolic molding compounds, foams and casting resins. For example, service experience has shown that certain phenolic foams are corrosive to plain carbon steel, and that certain phenolic casting resins are corrosive to cadmium-plated metal parts. Some phenolic laminates have caused metal parts to corrode in a sealed electric generator operating in a humid environment. Molded phenolic parts have caused many failures of metal springs and contacts by corrosion.

Rubbers—Here are four experiences on the corrosion of metals in contact with SBR and other rubbers:

1. A copper conductor in a mine case was corroded by contact with an SBR rubber washer.
2. Silver contacts in a switch sealed with a rubber-impregnated fabric were corroded, whereas nickel-silver springs were not affected.
3. Polysulfide (Thiokol) sealants reacted with cadmium-plated steel to give a black deposit of cadmium sulfide and ferrous sulfide.
4. Metal parts in a hydraulic system were corroded by rubber gaskets and o-rings.

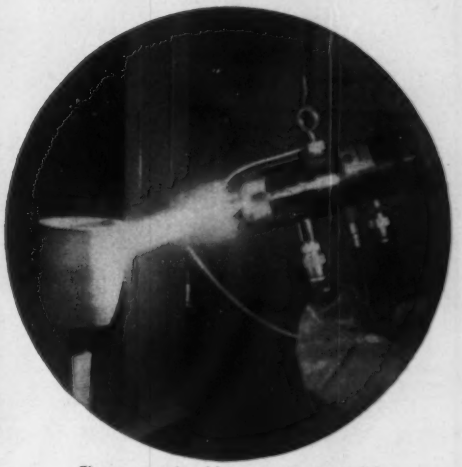
Vinyl resins—The Signal Corps and numerous radio and TV manufacturers have found that vinyl sleeving and vinyl wire insulations when heated above 212 F release acidic vapors which cause corrosion of metal parts.

Fluorocarbons—TFE (tetrafluoroethylene) and CFE (chlorotrifluoroethylene) resins corrode steel molds and molding equipment unless the molds and equipment are chromium plated. These plastics also corrode brass and copper inserts during molding unless the inserts are plated with gold or some other inert metal.

Cellulosics—Wood and wood flour fillers in plastics release corrosive materials such as acetic, formic and carbonic acids.

Plastics laminates—Polyester-glass cloth radomes have caused corrosion of adjacent aluminum structural parts on aircraft.

NOW—15,000°F. PLASMA FLAME SPRAY IN YOUR OWN PLANT



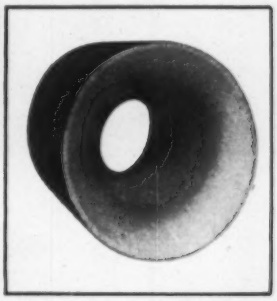
Flame spraying hi-temperature crucible

Apply coatings of high melting point materials such as tungsten, tungsten carbide, molybdenum, chromium carbide, titanium oxides, calcium zirconate, rare earth oxides. Operates at 10,000°—15,000°F.

Now any material that can be melted without decomposing can be sprayed. Despite high melting temperature, object sprayed stays cool.

High fluidity of particles and high velocity of impingement bond particles together to produce high density coatings semi-fused to work surfaces. Absence of air eliminates oxidation.

Spraying tungsten on brass mandrel



Tungsten coated graphite part

Metco Type MB Plasma Flame Spray Gun

Here is a valuable new tool for the metalworking research department or production line. The METCO Plasma Flame Spray Gun operates on inexpensive inert gases, with high electrical power conversion efficiency and long component life. Continuous hot gas streams, as high as 30,000°F., with accurate control of temperature, can be generated for costs of ⅓ to ½ those of oxygen-fuel gas equipment for equivalent heat output.

Other advantages include push-button operation, extremely simple training of personnel, elimination of flash-back and explosion problems.

Materials that can be sprayed

Specifically, a wide range of metals and their oxides, carbides, borides, and refractories have been sprayed with the standard apparatus on various shaped objects and mandrels. Coating densities are easily controlled and up to 98% of theoretical can be obtained. Lowered oxide contents, with improved bond and tensile strengths are additional advantages.

Plasma Flame — how it works

The METCO Plasma Flame Spray Gun produces an arc contained in a water-cooled nozzle. An inert gas, blown through and around the arc, is "excited" to energy states having temperatures approaching 30,000°F. This Plasma "Flame" is used for melting and spraying any desired material.

The METCO Plasma Flame Gun is the latest development in flame-spraying equipment by METCO. Write today for free bulletins describing the various flame spraying processes and the Plasma Flame Spray Gun.

Metallizing Engineering Co., Inc.

METCO

Flame Spray Equipment and Supplies
Westbury, Long Island, N. Y. • Cable: METCO
Telephone: EDgewood 4-1300
In Great Britain: METALLIZING EQUIPMENT CO. LTD.
Chobham-Near-Woking, England

Metallizing Engineering Co., Inc.
1175 Prospect Ave., Westbury, L. I., New York

Please send me free bulletin on the Metco Plasma Flame Spray Gun.

Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

For more information, turn to Reader Service card, circle No. 358

Republic High-Performance Titanium for the X-15

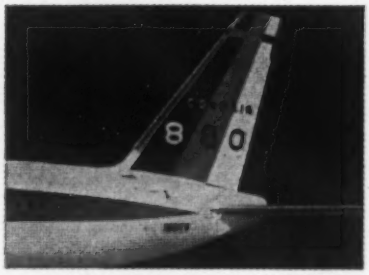
In a number of highly stressed components subject to extreme high and low temperature fluctuations, *high-performance* titanium in the X-15 Research Vehicle will help take man higher and faster than he has ever been before.

Republic Steel—a leading supplier of titanium, and the nation's largest producer of stainless and alloy steels—is supplying North American Aviation with Type 110A titanium for internal structures on the X-15 project.

Let us help you utilize *high-performance* metals to increase strength, resist heat, or trim weight. Write Republic Steel, Dept. ME -8591, 1441 Republic Building, Cleveland 1, Ohio.
Please indicate if you would like a titanium metallurgist to call.

REPUBLIC STEEL *Where Steels are*

FIRST POWERED FLIGHT of the North American X-15 came on September 21, 1959, over Edwards AFB. Carrying a full load of fuel (note frost from liquid oxygen at top and bottom of fuselage), the X-15 flew under power for 3.5 minutes at speeds in excess of Mach 2.

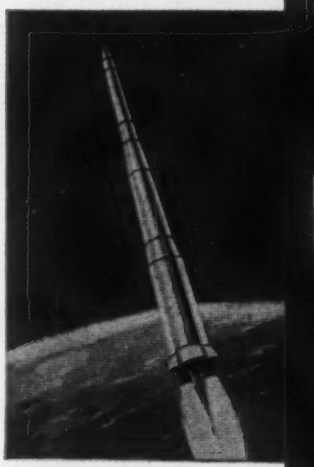


REPUBLIC STAINLESS STEEL is used in leading edges of the Convair 880's vertical fin and horizontal stabilizer where anti-icing is accomplished through electrical heating of the metal. Use of Republic ENDURO® Stainless Steel increases strength and heat-resistance, permits thinner, lighter gages. Types 301 and 302 are readily formed into desired shapes by cold forming, drawing, and bending operations.

REPUBLIC'S NEW HIGH STRENGTH POWDER, TYPE HS6460

is ideal for sinterings of highly stressed components. Provides minimum tensile strength of 60,000 psi at 6.4 density as sintered . . . 100,000 psi after heat treatment. Maximum of .004% shrinkage from die size at 6.4 density. Available in quantities up to and including 12 tons or multiples. Can be used with existing operating equipment.

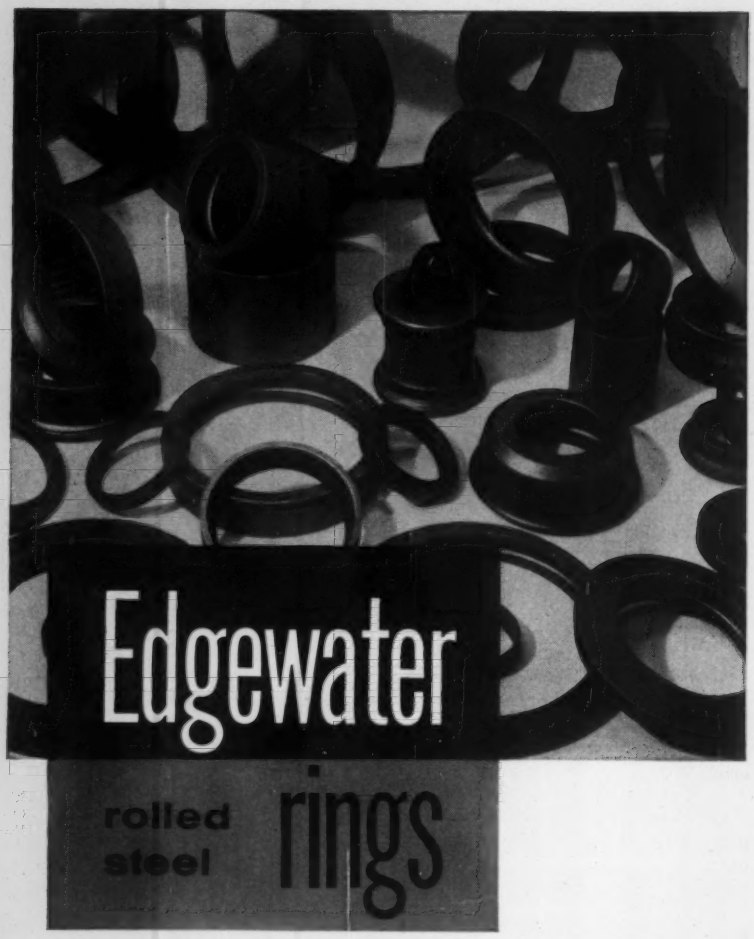
REPUBLIC VACUUM-MELTED ALLOYS heat treated to tensile strength levels of 270,000 to 300,000 psi are produced in fifteen thousand-pound heats for missiles such as the Minuteman. Vacuum arc process minimizes segregation and center porosity. Nonmetallic inclusions are reduced in number and size. Transverse ductility at high strength levels is also greatly improved.



Made to Meet the Challenge of Acceleration

REPUBLIC STEEL

For more information, turn to Reader Service card, circle No. 337



diameters 5 to 145 inches—accurate rolling reduces machining—simple or complex cross-sections—rolling gives strength, toughness

Rolled from solid blocks of steel, Edgewater Rings are strong and tough. Simple or complex cross-sections are formed to tolerances so close that only a minimum of machining is necessary. This means substantial savings in material and labor. Edgewater provides complete facilities for finishing and heat treatment, if required.

Write for descriptive illustrated bulletin.

Edgewater Steel Company

Dept. MDE • P.O. Box 478 • Pittsburgh 30, Pa.

For more information, turn to Reader Service card, circle No. 443

TECHNICAL LITERATURE

(cont'd from p 43)

Books

Introduction to Rubber Technology. *Edited by Maurice Morton. Reinhold Publishing Corp., New York. 1959. Cloth, 6 by 9 in., 550 pp. Price $10*

This book gives information on the production, compounding, fabrication, properties and uses of natural, butadiene-styrene (SBR), nitrile, polyacrylate, butyl, neoprene, polysulfide (Thiokol), silicone and reclaimed rubbers. It also gives information on accelerators, antioxidants, plasticizers, softeners, extenders, carbon black and nonblack compounding ingredients, as well as processing equipment.

Books on Aluminum.

Aluminum Construction Manual. *Aluminum Assn. New York. 1959. Cloth, 6 by 9 in., 392 pp. Price $3*

Subjects discussed include: 1) dimensions, weights and properties of aluminum structural shapes; 2) riveted and bolted connections; 3) allowable loads for beams and columns made of aluminum alloy 6061-T6; and 4) specifications and engineering data on nine aluminum alloys that fulfill most structural needs.

Kaiser Aluminum Forgings: Product information. *Kaiser Aluminum & Chemical Corp., Oakland, Calif. 1959. Cloth, 336 pp. Price $7.50*

Discusses advantages, properties, uses, fabrication and design data, tolerances and heat treatment of aluminum forgings. The book also describes present and future forging techniques. It contains a glossary of terms relating to aluminum forgings.

Atmospheric Exposure of Wrought and Cast Aluminum Alloys. *American Society for Testing Materials, Philadelphia. 1959. 100 pp. Price $1.75*

Results of the first three years of an exposure test program in which 27 aluminum and 8 magnesium commercial alloys are being exposed to atmospheres at five locations to determine changes in tensile strength, elongation and yield strength.

Alcoa Structural Handbook: 6th Revision. *Aluminum Co. of America, Pittsburgh. 1959. Cloth, 5½ by 8½ in., 420 pp.*

Information on the design of aluminum alloy strength members. The various chapters discuss characteristics, manufacture and fabrication, and give tolerances and commercial sizes of aluminum alloy products. The book also gives extensive data on the aluminum-magnesium alloys.

Books on Powder Metallurgy. *Proceedings of 15th Annual Meeting. Metal Powder Industries Federation, New York. 1959. Paper, 8 by 10 in.*

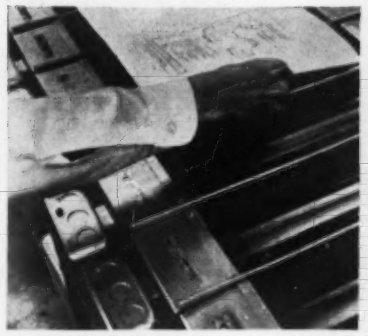
General Session on Powder Metallurgy. *105 pp. Price $4*

Subjects of the 12 papers given in this book are: 1) a new method for compacting metal or ceramic powders into continuous sections; 2) use of powder metallurgy for diffusion bonding of cemented carbide to steel; 3) some new applications of lead powders; 4) metal powders in concrete; 5) the effects of lithium stearate additions and various atmospheres on sintered brass compacts; 6) automatic control of endothermic sintering atmospheres; 7) direct measure-

THIS IS GLASS

A BULLETIN OF PRACTICAL NEW IDEAS FROM CORNING

HOW TO GET MORE USEFUL HEAT PER KW



It's not much to look at, but our new VYCOR Brand Radiant Heater is loaded with advantages for those involved with drying, baking, curing or pre-heating.

The basic appeal of this unit is the kind of heat it gives you—*long wave;* efficient because it's readily absorbed.

These long waves are emitted from wire coils enclosed in tubes of 96% silica glass. And the tubes (made from one of our rugged VYCOR brand glasses) resist heat, heat shock, and corrosion.

Long wave output is just one reason why your kilowatts will yield more useful heat. This heater also has a reflector *system* that includes a platinum strip bonded to one side of the tubing, and two layers of aluminized steel with Fiberglas insulation in the housing.

Result: Between 85 and 90% of the available radiation is directed to your work.

With VYCOR Brand Radiant Heaters mounted horizontally above or below your process line, you average 20 watts per square inch of working space and get full heating (800-850°F) in three minutes, so there's no costly warm-up delay. These units cool quickly, too, so you don't need complex equipment for diverting heat after shutting off the line.

Heating tubes come in 14", 26", 38" and 54" lengths, mounted in twos or fours. You get each unit complete with frame, reflector sheet, junction box, mounting hangers and leads.

More facts? Use the coupon.

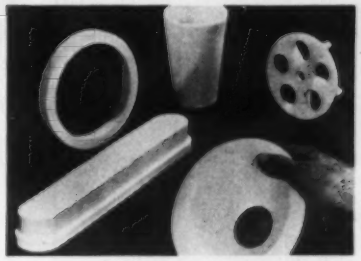
NEW MATERIAL FOR MISSILE MAKERS AND OTHERS WITH HIGH-TEMPERATURE PROBLEMS

The biggest drawback to fused silica, despite its many desirable thermal and electrical properties, has been the limitation on sizes and shapes available.

No more. Now Corning comes up with Multiform Fused Silica—a combination of a unique process and a versatile material.

With Multiform Fused Silica you can put the useful properties of fused silica to work in shapes and sizes that previously were unattainable.

For example, you can now have cylinders, domes, crucibles, rods and slabs—in sizes equal to any achieved by conventional ceramic forming processes.



Corning's new Multiform Fused Silica offers the unique thermal and electrical properties of fused silica in shapes and sizes that up to now were considered impractical.

Softening point for this new material is 2880°F; you can design for *long-term* use at temperatures over 1770°F, intermittent up to 2250°F.

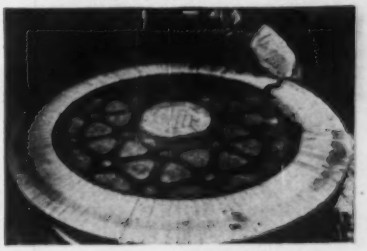
Resistance to thermal shock is high, since coefficient of expansion is 3×10^{-7} per degree F.

This new material also displays an extremely stable dielectric constant and a low loss tangent over a broad temperature range. Example: At a frequency of 8.6×10^{9} cps, the dielectric constant is 3.58 at 77°F and 3.57 at 750°F.

Through either slip-casting or dry pressing you end up with an object (a radome, perhaps?) that has an opaque, fine-grained structure machinable to tolerances of plus or minus .001 inch.

For samples of and/or detailed specs on new Multiform Fused Silica, mark the coupon and send it to our New Products Division.

A MIRROR FOR THE STARS



This is a glass telescope mirror blank that measures 84 inches across and weighs 4,000 lbs.

We made it. And we did it with a new process in which solid chunks of glass were placed in a mold and *sagged into a single piece* under intense heat.

Back in the thirties we also made some big mirrors. But then we ladled molten glass into molds and came up with a 200-inch disk for the Hale Observatory on Mt. Palomar and a 120-incher for the Lick Observatory.

Our new sagging approach improves quality. It also costs less and is less complicated.

Seven months the disk was annealed. Now at the Kitt Peak Observatory in Arizona, grinding and polishing will go on for an estimated 24 months. Final polishing will be done after the telescope is fixed on a star. Time for that? Another year.

Leading us to these facts: Patience is part of the art of the astronomer. And Corning can do almost anything with glass—be it a "one-shot," hand-tailored piece or *mass production of small items at a very rapid pace.*

Find out for yourself. The basic references are "This is Glass" and Bulletin IZ-1, "Designing with Glass for Industrial, Commercial and Consumer Applications."

Or outline your need in whatever detail seems feasible. Could be your star is just around the corner, with glass by Corning.

CORNING MEANS RESEARCH IN GLASS

CORNING GLASS WORKS 50 Crystal St., Corning, N. Y.

Please send me: ☐ "Corning Industrial Heaters"; ☐ Information on Multiform Fused Silica; ☐ "This is Glass"; ☐ Bulletin IZ-1

Name..... Title.....

Company.....

Street.....

City..... Zone..... State.....

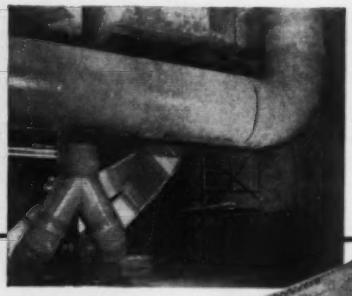
For more information, turn to Reader Service card, circle No. 325

corrosion resistant **DURACOR**

replaces costly metal fabrications

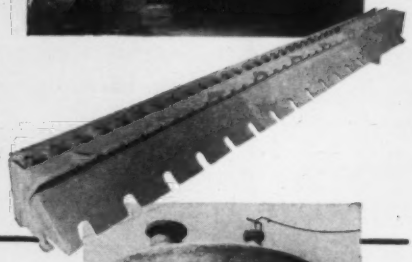
in the
METALWORKING
industry

Ceilcote engineers complete ventilating systems, gas scrubbing towers, hoods, tank covers, ducts, recovery tanks and other customized fabrications.



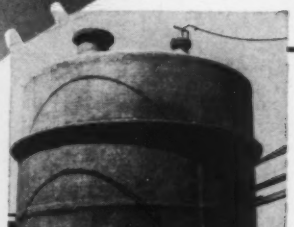
in the
TEXTILE
industry

Complex rayon spin machines, feed pipes, filters, screens, tanks and similar equipment are fabricated from Duracor.



in the
PETROLEUM
industry

Acid storage tanks, tank trailers, exhaust systems, pressure pipes and other Duracor products are rendering outstanding service.



in the
CHEMICAL
industry

Duracor is used extensively for special processing equipment, processing tanks, laboratory sinks, brine tanks, acid storage tanks, covers and ventilating systems.

PHYSICAL PROPERTIES

Tensile Strength p.s.i.: 11,000-15,000

Flexural Strength p.s.i.: 20,000-30,000

Tensile Modulus of Elasticity p.s.i.: $1.2—1.4 \times 10^6$

Flexural Modulus of Elasticity p.s.i.: $0.78—1.6 \times 10^6$

Impact Izod, Notched ft.-lbs./in.: 30—40

Specific Gravity: 1.4

Coefficient of Linear Expansion: 9.5×10^{-6} in./in./°F.

Standard Color: Light Green/Gray

Maximum Temperature (Exposure): To 500°F.

Save up to 40% over costly metal structures with Duracor processing equipment and ventilating systems! A product of Ceilcote's 33 years of corrosionproofing experience, Duracor combines extreme chemical resistance and high strength with light weight, heat and flame resistance. WRITE TODAY FOR VISUAL STANDARDS AND INDUSTRY SPECIFICATIONS!

THE CEILCOTE COMPANY, inc.
4899 Ridge Road • Cleveland 9, Ohio

DURACOR CEILCOTE

8135-CC

For more information, turn to Reader Service card, circle No. 351

TECHNICAL LITERATURE

ment of the particle size of fine metal powders; 8) detergency during infiltration in powder metallurgy; 9) current status of aluminum powder metallurgy; 10) a new basis for an inspection method for sintered metal components; 11) machinability of sintered iron; and 12) the advancement of powder metallurgy applications in the automobile. The book also contains a year-end report and a listing of MPIF members.

Special Session on Ceramic Permanent Magnets. *28 pp. Price $2.50*

Three papers in this book discuss: 1) magnetic torque couplings using ceramic permanent magnets; 2) power ferrites for the industrial field; and 3) use of ceramic permanent magnets in motors.

Reports

Welding titanium. METHODS FOR WELDING TITANIUM. *24 pp. 1959. American Welding Society, 33 W. 39th St., New York 13. Price $1.50*

This report tells how to weld titanium pipe and tubing by the gas tungsten-arc process. The various chapters discuss electrodes, filler metals, joint design, and weld quality tests.

Rare earth metals SELECTION AND EVALUATION OF RARE OR UNUSUAL METALS. PART 2. THE METALLURGY OF YTTRIUM AND THE RARE EARTH METALS. *B. Love. Mar '59. 188 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $3 (PB 151825)*

Information on yttrium and the rare earth metals, and alloys of titanium and beryllium with rare earth additions.

Wood laminate strength STATISTICAL PLAN FOR PHASE 1 OF DESIGN CRITERIA FOR WOOD LAMINATES. *A. Lieberman. July '57. 5 pp. Available from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C. Price $1.80 (microfilm and photocopy) (PB 139510)*

Determines the effect of lamination thickness and grain on the strength of curved and straight wood laminates.

Corrosion prevention CORROSION PREVENTION: PART M OF MAINTENANCE AND OPERATION OF PUBLIC WORKS AND PUBLIC UTILITIES. *Dec '56. 430 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $3 (PB 151756)*

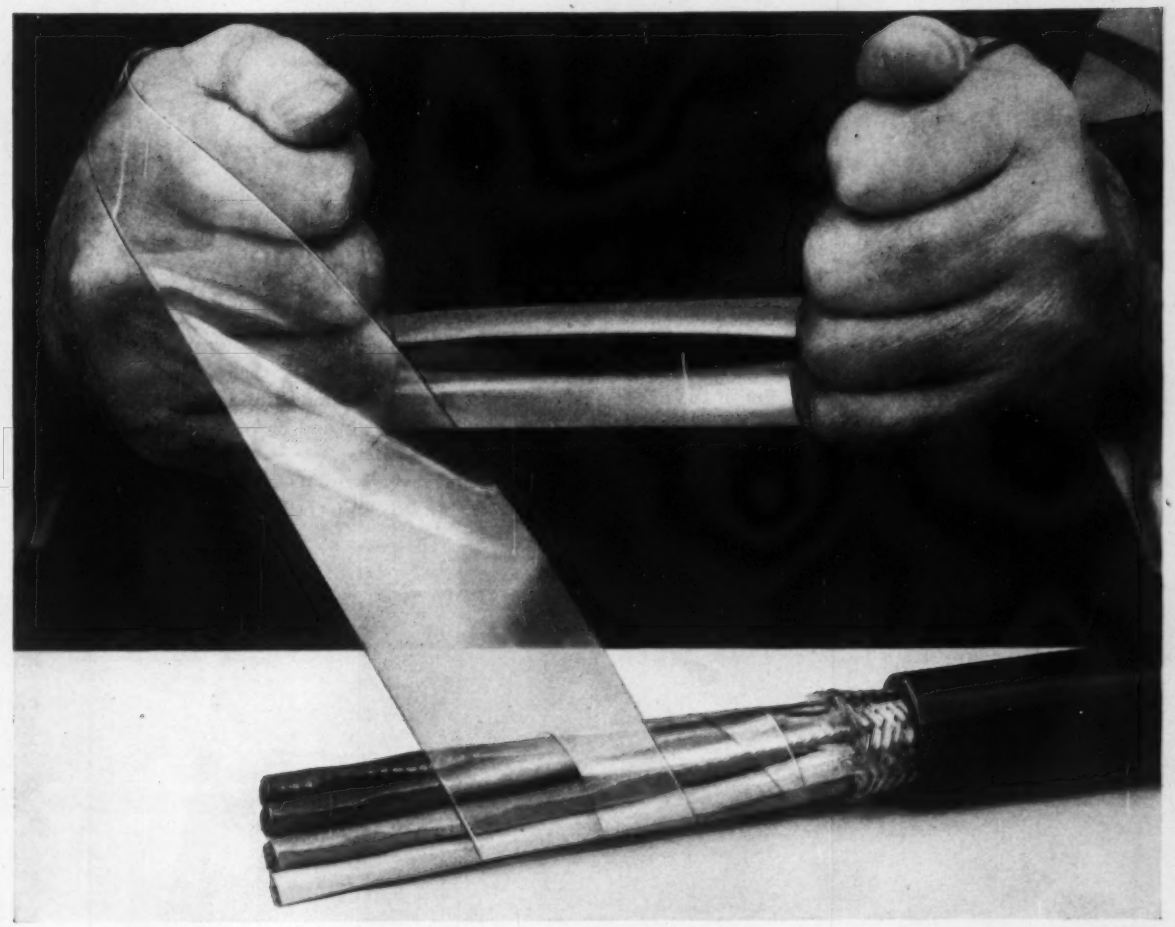
Provides information on the latest methods for control of atmospheric, submerged, and subsurface corrosion, and of corrosion in areas alternately wet and dry.

Aluminum at low temperatures TENSILE PROPERTIES OF LIGHT ALLOYS AT LOW TEMPERATURES. *L. M. Smith, Dec '58. 31 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1 (PB 151843)*

Gives tensile and yield strength, elongation and reduction of area for 28 wrought aluminum alloys and six aluminum casting alloys at temperatures of 75, –18, –112 and –320 F.

Ferrites. *J. Smit and H. P. J. Wijn. John Wiley & Sons, Inc., New York. 1959. Cloth, 6 by 9 in., 384 pp. Price $10*

Gives physical properties of ferrimagnetic oxides. These properties are in turn treated in relation to the chemical composition and crystal structure of the materials.



Tough tape of MYLAR® cuts cable costs . . . reduces size, weight

Can the unique combination of properties found in "Mylar" help solve your design problems?

Tensile strength of 20,000 psi . . . Bowling-ball test offers dramatic proof of the amazing strength and toughness of "Mylar" polyester film.

"Mylar"* polyester film is a tough, flexible engineering material. Used as a core binder tape for electric cable, "Mylar" prevents sharp braid wires from puncturing the primary insulation during cable manufacture. Replacing heavier, thicker materials formerly used, "Mylar" reduces size, weight, cost of cable.

In addition to its average tensile strength of 20,000 psi, "Mylar" has excellent resistance to most chemicals and moisture, a dielectric strength of 4,000 volts per mil for 1 mil film, and can withstand temperature extremes from –60° to 150°C.

On an area basis, tough, thin "Mylar" often costs less than heavier, conventional materials. "Mylar" can be laminated, embossed and metalized, punched or coated. The film won't become embrittled with age. "Mylar" is available in roll or sheet form in a wide range of gauges.

Find out how the combination of properties in "Mylar" can help you solve knotty design problems, improve product performance or cut costs. Write today for our new booklet containing detailed information on properties and applications. E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room MM-2, Wilmington 98, Delaware.

*"Mylar" is Du Pont's registered trademark for its brand of polyester film.

DU PONT
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BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT
MYLAR
POLYESTER FILM

For more information, turn to Reader Service card, circle No. 466

7% COST REDUCTION WITH AMERIPOL 1708 RUBBER

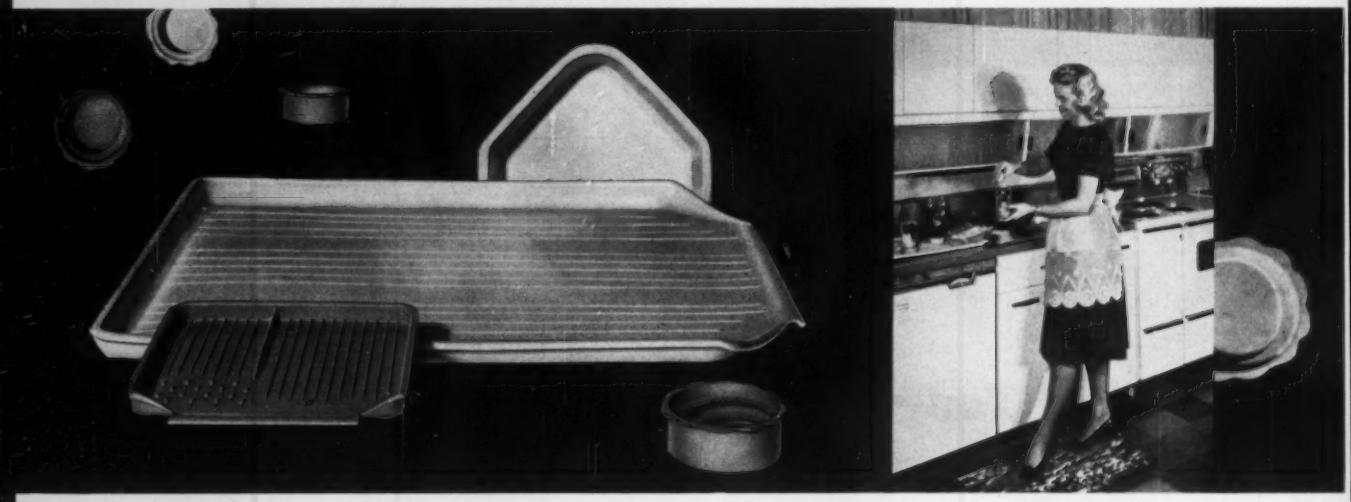
Improvements in color and quality of styrene-butadiene rubbers of higher oil content now permit use of these polymers in more and more applications. The cost savings are substantial.

For example, Ameripol 1708, a 37½-part oil polymer, costs 7% less than polymer 1703, one of the most widely used 25-part-oil types.

Extensive tests at Goodrich-Gulf Sales Service Laboratory show that physical properties of Ameripol 1708 compare favorably with the lower-oil type polymer. Physical test data is reproduced on the following page.

Whether you fabricate or use parts made of SBR rubber, it will pay you to use Goodrich-Gulf technical service. As producers of the widest selection of SBR rubbers, Goodrich-Gulf is in unique position to help you in proper application of this versatile material. Ameripol rubber is a preferred material for many uses —tire treads, conveyor and drive belts, rolls, molded and extruded products.

For information write Goodrich-Gulf Chemicals, Inc., 1717 East 9th Street, Cleveland 14, Ohio.



Ameripol 1708 cuts pigment cost

These attractive housewares are made of Ameripol 1708—a type that is supplied in such uniform light color that the manufacturer saves substantially by reducing the need for adding expensive pigments.

AMERIPOL TYPES AVAILABLE

Hot polymerized types: 1000, 1001, 1002, 1006, 1007, 1009, 1011, 1012, 1013

Cold polymerized unpigmented types: 1500, 1501, 1502, 4600

Cold polymerized black masterbatch types: 4650, 4651, 4652, 4654, 4655, 1605

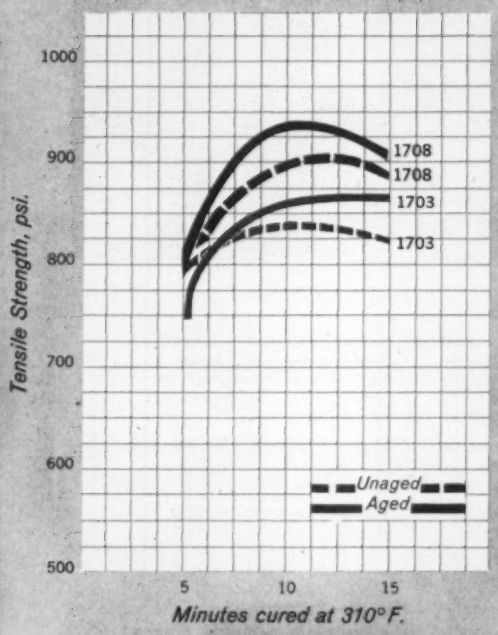
Cold polymerized oil-extended rubber types: 1703, 1705, 1707, 1708, 1710, 1712, 4700

Cold polymerized oil and black extended rubber types: 1805, 4750, 4751, 4752, 4753

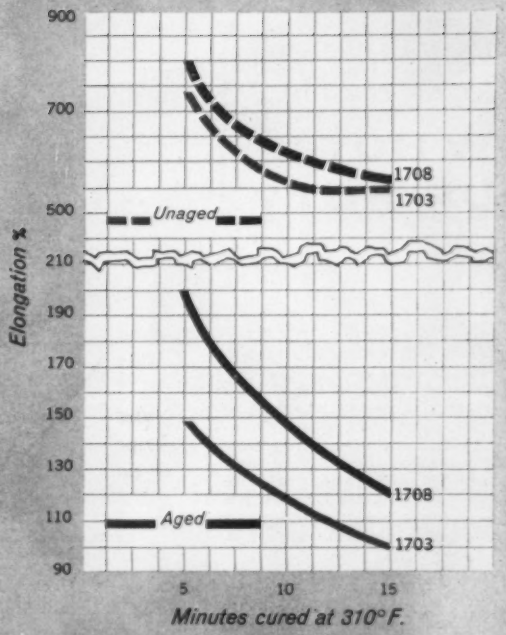
Forms available: Pressed rubber bales, crumb rubber. Packaging to suit requirements.

Ameripol
THE PREFERRED RUBBER

For more information, circle No. 469



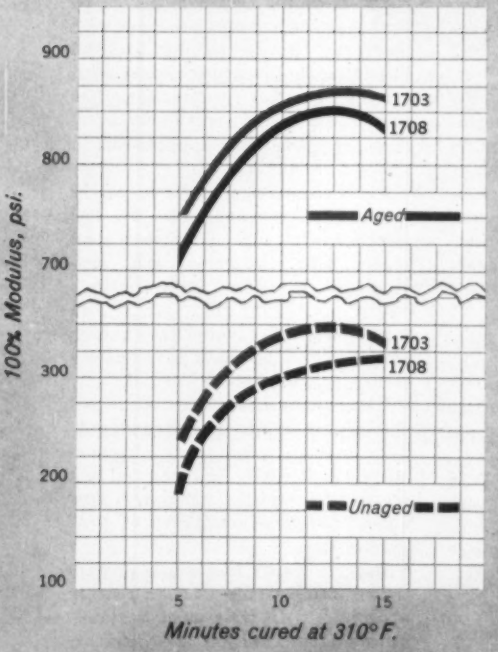
TENSILE STRENGTH



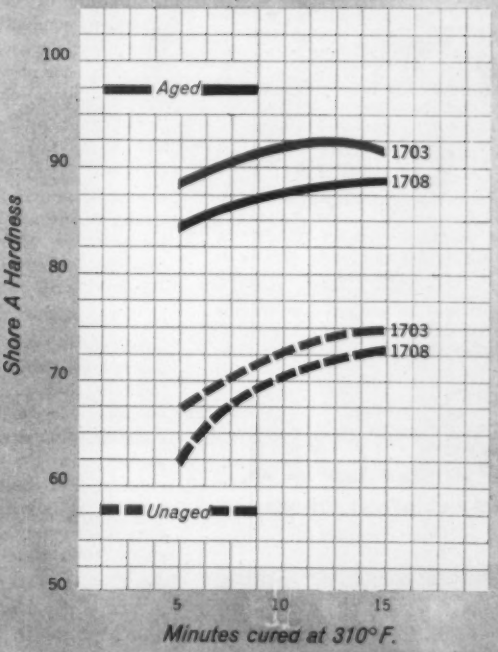
ELONGATION

Comparative tests prove performance of **AMERIPOL 1708**

MODULUS



HARDNESS



Goodrich-Gulf Chemicals, Inc.

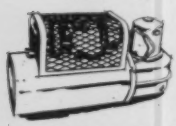
When you're choosing a protective coating...

HOW HOT IS YOUR HOT?

A Nose Cone Gets Hot

When conventional organic finishes were used in Chrysler Redstone Missile tests, they ignited and disintegrated under simulated re-entry conditions. Sicon survived because it possessed the inherent heat resistance to meet performance requirements. This has been confirmed in large scale tests and actual missile firings.

A Truck Heater Gets Hot



A porcelain type coating used on a truck heater failed because it could not stand the thermal shock of rapid heating and cooling. The same heating (550°-600°F.) and cooling left Sicon's film integrity unaffected.

A Tractor Engine Gets Hot

A farm equipment manufacturer used a bright organic red color on their standard equipment. The coating on the engine parts, which were subjected to high temperature, quickly decomposed. Midland engineers developed a matching bright Sicon Red which retained its color and gloss and protected the hot spots on the engine.

How HOT is your HOT?

Sicon possesses the flexibility of ordinary organic finishes and the heat resistance of ceramic coatings—up to 1000°F. in black or Aluminum; up to 550°-600°F. in decorative colors. Upon inquiry a sample Sicon formulation for testing your "hot" requirements will be prepared at no obligation. Send details of your "hot spot" problem today to Dept. 1-B.

Sicon®

HEAT RESISTANT FINISH

A Silicone Product of

MIDLAND

INDUSTRIAL FINISHES COMPANY

WAUKEGAN · ILLINOIS

ENAMELS · SYNTHETICS · LACQUERS · VARNISHES

For more information, circle No. 356

What's new IN MATERIALS

(cont'd from p 116)

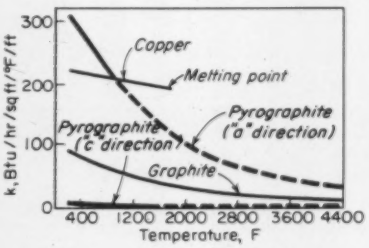


***Fig 1**—Note high thermal conductivity of Pyrographite in the "a" direction; low conductivity in "c" direction. Also, conductivity decreases with increasing temperatures.*

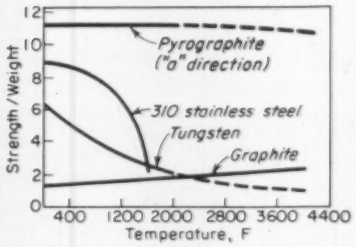


***Fig 2**—Strength-to-weight ratio of Pyrographite remains high at temperatures as high as 4000 F.*

of Pyrographite in both the "a" (parallel to surface) and "c" (perpendicular to surface) directions. At temperatures below about 900 F, Pyrographite has thermal conductivity in the "a" direction higher than that of copper; in the "c" direction, conductivity is lower than that of conventional graphite. This characteristic provides excellent thermal insulating characteristics.

Thermal conductivity of conventional ceramics generally tends to increase with increasing temperatures. Conductivity of Pyrographite tends to decrease with increasing temperature. Consequently, insulating properties at higher temperatures are even better than those at lower temperatures.

Complete electrical property data are not available as yet. Initial data indicate that resistivity in the "c" direction increases with higher preparation temperature, whereas resistivity in the "a" direction decreases. For material prepared at 3600 F, resistivity in the "c" direction (across the layer planes) is about 1000 times that in the "a" direction. Resistivity along the layer planes is considerably less than for normal graphite, which is considered a good conductor; across the layers it is far greater than that of graphite.

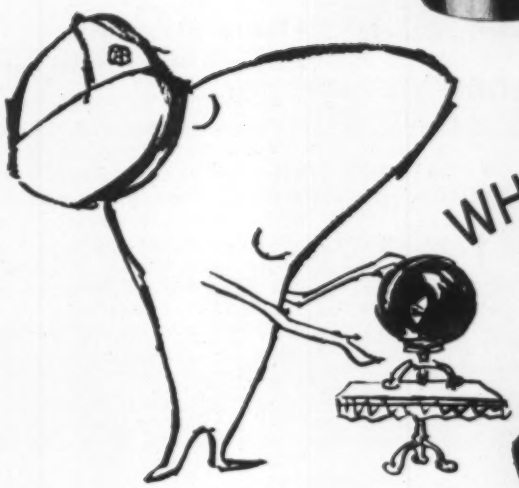
Physical and mechanical properties

Theoretical density of normal graphite is 141 lb per cu ft; commercial graphites average around 99 to 106 lb per cu ft; and densified graphites range from 106 to 125 lb per cu ft. Pyrographite has been prepared with measured densities as high as 138.5 lb per cu ft. Density increases with temperature of preparation. Increased density is particularly desirable for moderator applications in nuclear reactors.

Fig 2 compares strength-to-weight ratios of Pyrographite in the "a" direction with that of stainless steel (type 310), tungsten and conventional graphite. Pyrographite's strength-to-weight ratio, superior to that of the other materials at lower temperatures, becomes far superior at temperatures above 3600 F.

Various tests have been conducted with Pyrographite and normal graphite in high velocity, high temperature gas streams. The material has shown little erosion, compared with almost complete breakdown of graphite.

Impermeability to gases is of particular interest for nuclear reactor applications. In tests using a standard mass spectrometer leak detector, no permeation by helium has been detected. Impermeability is retained after cyclic heating to 4500 F and



WHAT KIND OF OIL SEAL DO YOU NEED?

The "custom" approach to oil seal manufacture, pioneered by IPC, has resulted in some real off beat products.

None-the-less . . . they *work!* They suit the application *and*, in more cases than not, they have contributed substantially to cost savings.

When you're faced with a rugged problem involving oil seals, what synthetic compound comes to mind? How about case design? . . . friction? . . . torque? . . . shaft speeds?

Oil seals are an engineered product in themselves . . . just as good as their individual design. That's why we think each oil seal application deserves special "custom" thinking. That's why IPC oil seals are noted for performance. Let us show you what IPC can do to relieve your particular problem.

OIL SEALS / PACKINGS / PRECISION MOLDING *Custom designed for your application.*

IPC

INTERNATIONAL PACKINGS CORPORATION

Bristol, New Hampshire

© IPC

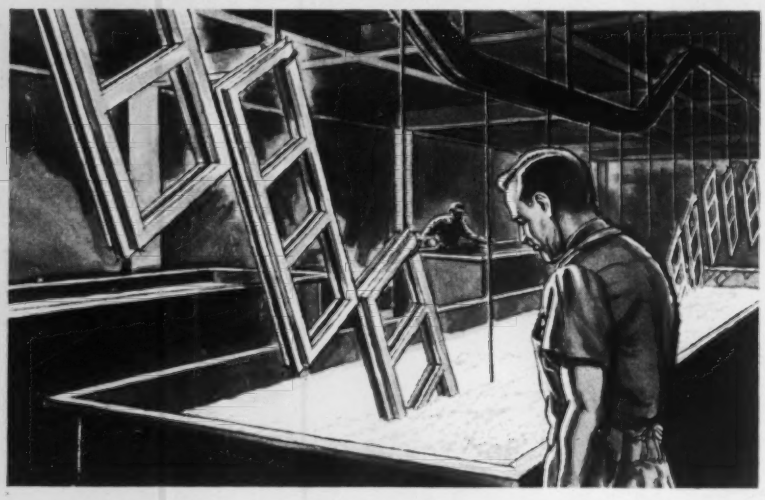
P-1

For more information, turn to Reader Service card, circle No. 423

Before you etch aluminum

ask Oakite

OVER 50 YEARS CLEANING EXPERIENCE • OVER 250 SERVICE MEN • OVER 160 MATERIALS



Oakite controlled aluminum etch provides safe, uniform mat finish

When your aluminum parts come out of an Oakite etching bath, you know exactly how deep an etch to expect. To give you this sure control, Oakite provides a variety of alkaline etching compounds. Each has its own rate of 'bite' and each is safe because the rate is dependable and uniform.

For instance, if you want a fine grain etch at moderate cycling speed—Oakite Composition No. 30 might be recommended by your Oakite man. Or, if you want a faster or deeper etch—Oakite 60, 130, or 160 might be the best choice.

Oakite controlled etching gives you a perfect satin finish when you want to enrich the natural beauty of aluminum, as on window frames or storm doors. When you want to prepare aluminum for paint, anodizing or lacquering, you get just the mat finish you need.

All Oakite alkaline materials are controlled to provide an identical rate of etching, batch after batch. One material is exactly right for your process, your alloys. Which one? Ask your Oakite man, or write for more information to Oakite Products, Inc., 45B Rector Street, New York 6, N. Y.

it PAYS to ask Oakite

Export Division
Cable Address: Oakite

OAKITE
50 1909-1959 SCIENCE
years' leadership in industrial cleaning

Technical Service Representatives in Principal Cities of U. S. and Canada

For more information, turn to Reader Service card, circle No. 366

recooling, even in films as thin as 1-2 mils.

The process

Oriented graphite has been produced in the laboratory for many years in minute quantities, e.g., as a thin coating on a hot filament. The commercial process, developed by Raytheon, provides for the molecular deposition on a substrate of graphite from a carboniferous gas. Pieces can be produced by deposition on the inner surface of a graphite mandrel, which is then cracked apart and separated from the workpiece.

KEY NO. 608

Fluoro-Elastomer Resists Heat, Solvents

A new type of rubber has recently been added to Du Pont's family of Vitron fluoro-elastomers. The rubber, called Viton B, is said to have increased resistance to high temperatures and to certain solvents, oils and chemicals.

Viton, introduced in 1957 (M/DE, July '57, p 96) and made available in 1958 (M/DE, May '58, pp 12 and 166), is a copolymer of vinylidene and perfluoropropylene. It currently sells for $10 per lb

Properties

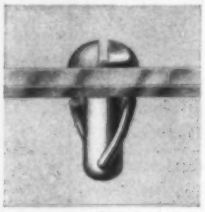
Viton B has about the same elongation, compression set, tensile strength and resilience as Viton A. However, Viton B has higher hardness, better tear resistance at both room and elevated temperatures, and higher modulus.

Tests show the new material has somewhat better abrasion resistance and better electrical properties than Viton A. Ozone resistance is said to be excellent, and radiation resistance under exposure to gamma radiation from a cobalt-60 source is equivalent to that of Viton A. The improved product, like Viton A, will not support combustion.

Heat resistance—According to Du Pont's Elastomer Chemicals Dept., Wilmington, Del., Viton B has better retention of elongation and less change in hardness after aging at 500-600 F than any commercial elastomer now available. The producer says, "While some loss in tensile strength is noted, embrittlement of

How can you use SPRING-LOCK?

THE FASTENER WITH USES UNLIMITED



As a standard removable fastener or a blind rivet

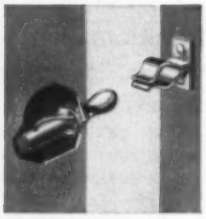
A quarter-turn locks, unlocks. Load-carrying steel arms lock securely, don't loosen under vibration. One-piece (no receptacle) simplifies blind fastening.

As a roller axle

Now used on range drawers, kitchen cabinets, file cabinets, desks. Cuts installation costs, saves time. Designed to suit. Available with or without roller.

As cup hooks

High-strength polystyrene or chrome-plated die cast zinc. Inexpensive, sturdy and good-looking. Simply and quickly installed with a twist of the wrist.



As a cabinet door strike

Millions in use on kitchen cabinets, automatic dishwashers, etc. Standard strikes available from stock, or custom designed for special contour requirements.

As a plastic shelf support

. . . with the heart of steel for extra strength. Millions now used by all major refrigerator manufacturers. Complete flexibility of head design.

What is <u>your</u> application for

SPRING-LOCK?

Send us your application inquiries. Our engineers will answer you specifically and promptly. Or, write today for the Simmons Catalog. SPRING-LOCK samples are available upon request.

SIMMONS FASTENER CORPORATION

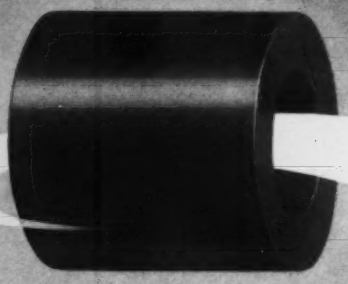
1759 North Broadway, Albany 1, New York

QUICK-LOCK • SPRING-LOCK • ROTO-LOCK LINK-LOCK • DUAL-LOCK

See our 8 page catalog in Sweet's Product Design File

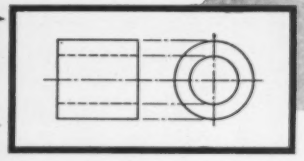
For more information, turn to Reader Service card, circle No. 340

HYDRO-AIRE specifies MORGANITE



—for extra reliability in *hytrol* anti-skid braking systems!

Hytrol Anti-Skid Braking Systems, a development of Hydro-Aire Company, are widely used on fighters, bombers, commercial transports and surface vehicles. Self-lubricating Morganite components are employed in these systems because of their smooth-functioning, reliable performance. Another example of Morganite's ability to meet today's critical requirements.



Designers/Engineers!

Make it Morganite . . . the material of a thousand applications. Morganite is universally specified for extra reliability in seals, bearings, contacts, pump vanes, meter valves and vital military applications. It functions with high efficiency in corrosives, oil, grease and grit . . . at high temperatures and under high pressures.

JET ENGINE PUMP VANE

WET OR DRY PUMP SEAL/BEARING

DRUM CONTROLLER CONTACT

SELF-LUBRICATING RADAR CONTACT

Request data and recommendations on your design requirements —

Morganite . . FOR OVER HALF A CENTURY

INCORPORATED

3324 48th Ave., Long Island City 1, New York

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Manufacturers of Fine Carbon Graphite Products including Mechanical Carbons, Motor and Generator Brushes, Carbon Piles, Current Collectors and Electrical Contacts . . . Distributors of 99.7% Pure Al_2O_3 Tubes and Crucibles

For more information, turn to Reader Service card, circle No. 380

What's new IN MATERIALS

PROPERTIES OF VITON RUBBERS COMPARED

Type ➡	A	B
Ten Str, psi		
77 F	2375	2250
300 F	450	500
Elong, %		
77 F	350	390
300 F	225	130
Modulus at 100% Elong, psi		
77 F	300	550
300 F	100	360
Hardness (Shore A, 77 F)	66	74
Resilience (77 F), %	43	47
Brittle Point, F	−47	−49
Power Factor, %	3 to 4	2.5
AFTER AGING 7 DAYS AT 400 F IN MIL-L-7808		
Ten Str Chg, %	−40	−29
Elong Chg, %	−13	−2
Vol Chg, %	+19.6	+9.3
AFTER AGING 7 DAYS AT 75 F IN BENZENE		
Ten Str Chg, %	−27	−21
Elong Chg, %	—	—
Vol Chg, %	+19.6	+12.
AFTER AGING 7 DAYS AT 300 F IN TRI-CRESYL PHOSPHATE		
Ten Str Chg, %	—	—
Elong Chg, %		
Vol Chg, %	+24	+6.9

Viton B at elevated temperatures occurs much more slowly, and useful elasticity is prolonged to the point where service life is twice as long as that of other synthetic rubbers in many applications."

Solvent resistance—Viton B is said to have the same high resistance to oil and solvents as Viton A. However, the new type of rubber is said to have superior resistance to diester lubricants, benzene, tricresyl phosphate, and phosphate ester hydraulic fluid.

Chemical resistance — The new elastomer has good resistance to sodium hydroxide and nitric acid at 158 F. It also has good resistance to red fuming nitric acid and glacial acetic acid at room temperature.

KEY NO. 609

Lacquers for Plastics

Quick-drying lacquers, called Rez-N-Lac A12, are said to provide nontoxic, waterproof, slow burning

Engineers:
Here are sound reasons why it pays to specify
USS National Seamless Mechanical Tubing

USS National Seamless Steel Mechanical Tubing offers you extraordinary freedom of design in a wide range of products from bushings to hydraulically operated telescoping booms. And, USS National Seamless Tubing helps cut processing costs, because it eliminates drilling operations; enables you to replace drills with simple, less expensive boring tools, and it reduces tool wear and tool changes; and, more important, more uniform parts can be turned out by the hundreds of thousands.

Where USS National Seamless Tubing is used as a load-carrying member or part, it exhibits a number of structural advantages over other forms. *Here are a few:* it gives you a superior cross section when a part is designed to withstand equal loading in any direction; it resists bending stresses equally in all directions; it is able to absorb and localize shock; and in torsion, it provides better material distribution, and for a given weight, can withstand more load than other sections.

And, of course, the name USS National is backed by the world's largest and most experienced manufacturer of seamless tubing—National Tube! The production of USS National Seamless Tubing, from ore to finished product, is entirely controlled by one organization. There is no divided responsibility. Every foot, every length, is made under the careful supervision of skilled men with years of tubemaking experience. For more than 60 years, USS National Seamless Tubing has been first with men who want the best in mechanical tubing.

You'll find USS National Seamless Tubing available at select National Tube Distributors throughout the country. These distributors are strategically located and expertly trained in solving all types of tubing problems. Here, you can choose from a complete range of sizes and stocks. If you'd like to find out how USS National Seamless Tubing can be most effectively applied to your designs, contact your nearest USS National Distributor . . . *soon!*

USS and National are registered trademarks

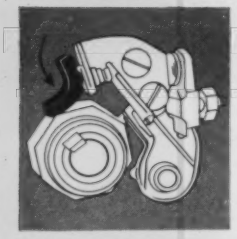
National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Supply Division
United States Steel Export Company, New York

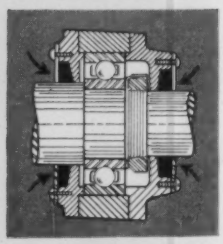
For more information, turn to Reader Service card, circle No. 396

How
FELT
BY FELTERS
Can Improve Product
SEALING and LUBRICATION

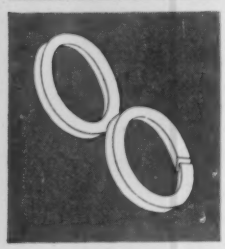
DuFelt is a laminated combination of Felters' felt and Hycar; and is recommended for sealing of lighter oils when no head exists. Seals and lubricates at the same time; and offers improvements over other materials.



Felt is an ideal wicking and lubricating material which can be designed into special assemblies like this distributor cam shown here. Lubrication is constant, wear reduced, and felt can be shaped to cover all required areas.



Lifetime bearing lubrication is now possible by selection of correct SAE grade, and designing into sealed bearing. Felt filters out contamination and works as combined reservoir and wick, directing oil flow to required areas.



Mechanical felt seals permit a close seal without undue pressure. Felt can be waterproofed and provides superior grease and oil retaining and dust, dirt and grit exclusion.

To help you get the most out of FELT, send for the Felters' Design Book. Write, today.

Ask for **FELT** *from...*
The **FELTERS** Co.
220 SOUTH STREET
BOSTON 11, MASSACHUSETTS
Pioneer Producers of Felt and Synthetic Non-Woven Fabrics

PE 9-18

What's new IN MATERIALS

properties to cellulose acetate toys, food packages and other products subjected to body contact. The lacquers were developed by Schwartz Chemical Co., Inc., 50-01 2nd St., Long Island City 1, N. Y.

KEY NO. 610

Brazing Alloy Used for Stainless Honeycomb

An aluminum oxide dispersion-hardened alloy has been developed by Martin Co., Baltimore 3, Md. for brazing stainless steel honeycomb structures.

According to Clarence A. Boyce, Jr., research assistant in the company's RIAS Div. (Research Institute for Advanced Studies), the new alloy overcomes most of the limitations encountered with conventional brazing alloys—namely uneven filleting and poor corrosion resistance.

The dispersion-hardened alloy is used in the form of a foil in combination with a silver-lithium foil for brazing face skin to honeycomb core. During the brazing cycle the lithium in the silver-lithium alloy fluxes the core and skin thoroughly, producing a sound, strong brazed joint between skin and core.

How alloy is made

Boyce says the new alloy is produced according to established powder metallurgy techniques: 1) aluminum oxide is dispersed in a metal matrix (composition not revealed) by milling; 2) the mixture is heated in a hydrogen atmosphere, then pressed into a briquette and sintered; 3) the briquette is cold rolled into a foil measuring 0.001 in. thick.

KEY NO. 611

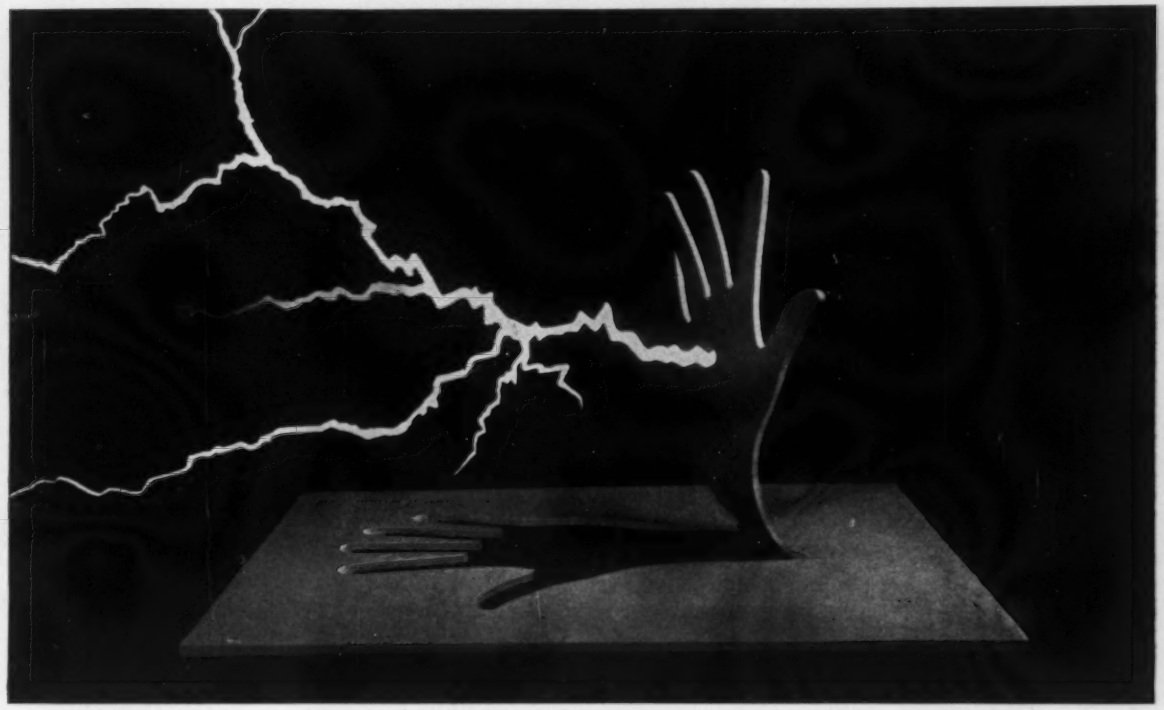
Duplex Electroplates Lengthen Part Life

Greater protection against corrosive environments is promised with a new plating technique that applies two layers of nickel under a layer of chromium. According to the developer, automobile bumpers plated by the process retain their bright appearance for the life of the car.

The duplex nickel plating technique was developed by Udylite Corp., 1651 Grand Blvd., Detroit 11. It is called Bi/Nickel. The process

For more information, turn to Reader Service card, circle No. 412

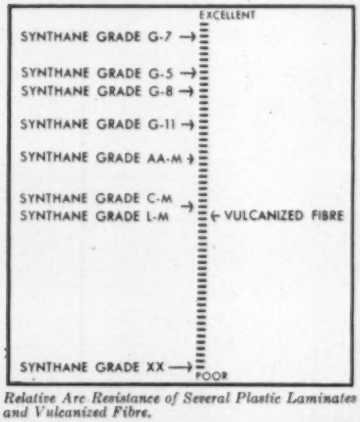
Arc Resistance with Synthane Laminated Plastics



Resistance to arcing is important in such applications as terminal boards, switch and fuse blocks, and circuit breakers. Usually, however, arc resistance alone is not sufficient to satisfy job requirements. Ceramics, for example, are excellent for arc resistance but they break easily and are difficult to machine. Mica has excellent arc resistance yet lacks strength.

Laminates have arc resistance plus

Laminated plastics have many desirable properties in combination. All grades of plastic laminates have good electrical properties. All have good dielectric strength, dissipation factor and insulation resistance. Some laminates also have excellent arc resistance and some—the phenolic laminates, for instance—are relatively poor in this respect.



Relative Arc Resistance of Several Plastic Laminates and Vulcanized Fibre.

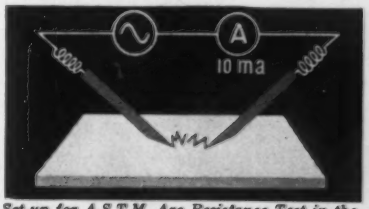
It is this failing of the phenolic grades which may have deterred you from thinking of laminates when arc resistance was required. But, outstanding progress has been made to supply laminates with excellent arc resistance. For example, Grades CM, LM, G-5 and G-7 have outstanding arc resistance properties.

There are several tests for arc resistance. One commonly used is ASTM Method D495-56T, which approximates service conditions in alternating current circuits operating at a high voltage, with currents limited to units and tens of milliamperes. Two pointed electrodes, ¼" apart (see drawing), rest upon the material to be tested. The arc is applied intermittently, and at first mildly. Later the time between flashes is decreased and the amperage is increased until the arc finally burns a conducting path between the electrodes. The total time in seconds until failure occurs is the arc resistance of the material.

Arc resistance is related to time

Since the severity of the arc is progressively increased, the comparative arc resistance of two materials is not in direct proportion to the time. The accompanying chart gives you a fairly accurate relationship of the arc resistance of Synthane laminates—using the ASTM method. The first four are glass base grades. G-7, containing a silicone resin, tops the list in arc resistance as well as in dielectric strength, dissipation factor, insulation resistance and moisture resistance.

For specific information relating to Arc Resistance for your application or for the combined properties of Synthane laminates, write **Synthane Corporation, 3 River Road, Oaks, Pa.**



Set-up for A.S.T.M. Arc Resistance Test in the Synthane Laboratory.

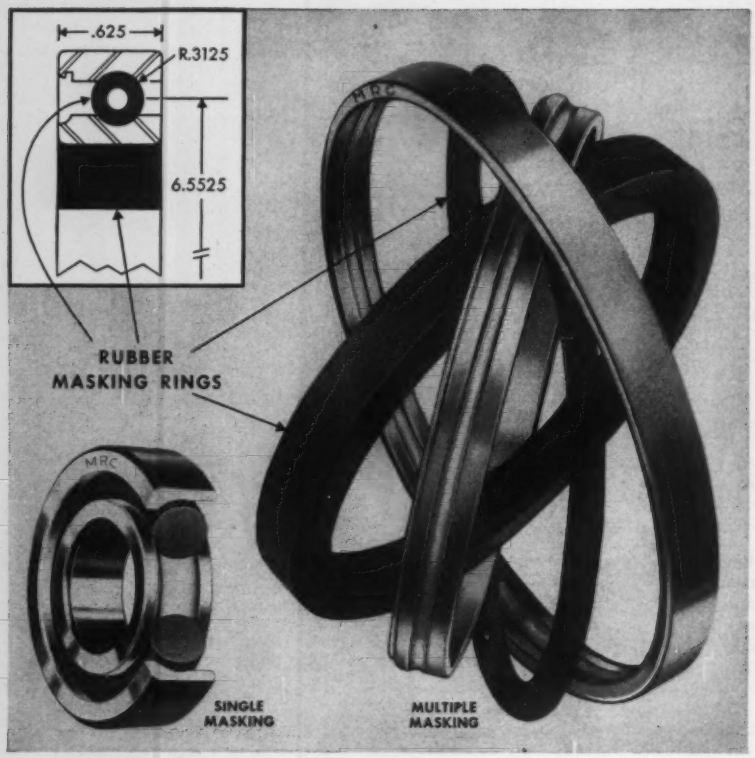
SYNTHANE

CORPORATION **OAKS, PENNA.**

Laminated Plastics for Industry

Sheets, Rods, Tubes, Fabricated Parts
Molded-laminated, Molded-macerated

For more information, turn to Reader Service card, circle No. 457



Photos courtesy Marlin-Rockwell Corp., Jamestown, N. Y.

Rubber Rings Mask Bearings during Plating Process

Here's a new way to mask out plating on bearing race grooves without tedious hand-labor. Regardless of bearing size, rubber rings are fitted precisely into ball grooves and inner ring bore so that plating can't sneak under the rubber even in torturous electroplating baths. Clean division lines always result. Inner ring and outer ring are held together so both can be plated simultaneously. This saves one complete plating cycle. And, this fast assembly prepares bearings for plating in seconds—eliminates costly hand-painting with unreliable stop-off lacquer.

These rubber rings are the result of Marlin-Rockwell Corporation (Jamestown, New York) consulting Continental to solve an important masking problem. Creative engineering successfully developed these extruded and spliced, or molded rubber rings which increased production 2000%—20 times faster than hand-painting. What's more, the special rubber compound withstands repeated baths in blistering acids and caustics without affecting precise dimensions, elasticity or resilience.

This rubber ring technique is typical of the thinking and ingenuity behind rubber parts by Continental. It also represents the economy and better end results accomplished by consulting a rubber specialist *during the planning stage* of a product. If you need help like this, call or write Continental—rubber specialists since 1903.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**
engineered by **CONTINENTAL**

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For more information, turn to Reader Service card, circle No. 411

What's new IN MATERIALS

joins two other duplex plating techniques introduced last fall (see M/DE, Sept '59, p 136).

Parts are first coated with a heavy layer of semi-bright nickel, then a layer of bright nickel, and finally a layer of chromium. The developer says the bright nickel layer adheres well to the semi-bright nickel layer.

Parts plated by the technique have successfully passed both the Corrodkote and the Cass (copper-accelerated acetic acid salt spray) tests for corrosion resistance.

KEY NO. 612

Resistance Alloy Is Corrosion Resistant

A modified iron-chromium-aluminum electrical resistance alloy is said to have corrosion resistance, strength and ductility properties comparable to those of the more costly nickel-chromium resistance alloys.

The corrosion resistance properties of the alloy are said to be superior to those of other iron-chromium-aluminum alloys. For example, the alloy has a weight loss of 4.5% after immersion in 10% hydrochloric acid for 1 hr at 140 F compared to a weight loss of 89% for other iron-chromium-aluminum resistance alloys tested under the same conditions.

The alloy is also said to have low density (0.262 lb per cu in.), high electrical resistivity (815 ohms per cmf), and a low temperature coefficient of resistivity (0.10×10^{-6} per °F).

The new material, latest in a series of noncritical resistance alloys (see M/DE, Mar '58, p 180 and July '58, p 128), was developed by Hoskins Mfg. Co., 4445 Lawton Ave., Detroit 8. It is called No. 815-R.

Electrical properties obtained in melt

According to the developer, the alloy's high resistivity and low temperature coefficient of resistivity are obtained in the melt rather than by aging treatments as is the case with nickel-chromium resistance alloys. These "in the melt" properties are said to minimize the effects of winding tension and heat on the material's electrical properties.

The alloy, which is magnetic, is

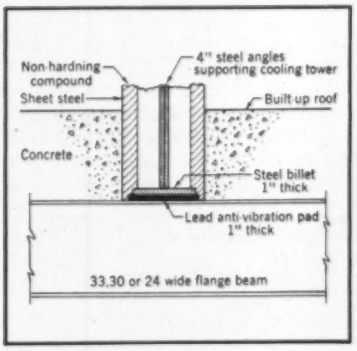
the LEAD newsletter

Lead Controls Vibration and Noise

Lead plays a vital role in the success of many of the more advanced developments in sound attenuation and vibration control.

New Skyscraper Depends on Lead To Damp Railroad Vibration

Building a towering office building over a dense network of railroad tracks . . . as was done in the case of the new Union Carbide skyscraper . . . presented a difficult problem of vibration control. It was solved by the use of lead-asbestos pads . . . a technique used by the architects of many of the adjoining buildings in New York City's Grand Central Station area. These lead cushions utilize lead's unmatched vibration damp properties. They'll substantially reduce vibration for the life of the building. These lead vibration pads serve an amazing variety of industries. High speed printing presses, for example, also make excellent use of lead's vibration damping properties.



Lead Isolates Vibration and Noise of Air Conditioning Unit

The huge air conditioning unit atop another new skyscraper at 575 Lexington Avenue in New York City keeps the building's occupants comfortably cool . . . quietly, thanks to lead. Anti-vibration pads made of lead-asbestos shield the building from the noise and vibration of this huge unit. Because they and the cooling tower's supporting steel columns can be placed in position while the steel work is in progress . . . in contrast to other methods, which would necessitate waiting until the concrete had been poured . . . the lead-asbestos pads shortened installation time considerably.

Jets, Helicopters, Use Lead

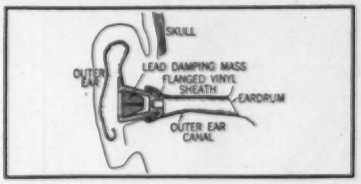
Lead impregnated vinyl has found wide usage in abating noise in conventional and jet airliners as well as in helicopters. The special ability of lead to absorb or damp sound in the low frequency range . . . makes it ideal for shielding the occupants of the aircraft from ear splitting engine noise. In this product, lead-powder-impregnated vinyl is employed to coat a cotton duck or woven glass fabric, thus adding the strength and flexibility characteristics of vinyl, glass, and cotton to the noise isolation qualities of lead.

Electric Typewriters Damp Vibration with Lead, Too

Lead impregnated vinyl also is used in the latest electric typewriters to damp the high frequency vibrations which occur in the keyplate and paper table. For ease of application, the material comes with a pressure sensitive adhesive backing.

Lead Controls Vibration in "White Noise Room"

To test the effects of vibration on the drift rate of gyros and accelerometers, Minneapolis-Honeywell researchers have created a "White Noise Room" at their Inertial Guidance Center. In this room, where the mechanical noise and vibrations of missiles and space ships are exactly duplicated, lead is used as a damping mass to confine vibration and noise to the test area and to dissipate energy. In addition to minimizing vibration, non-ferromagnetic lead eliminates any magnetic field disturbances that could interfere with other work in the area.



Navy Uses Lead Ear Plugs

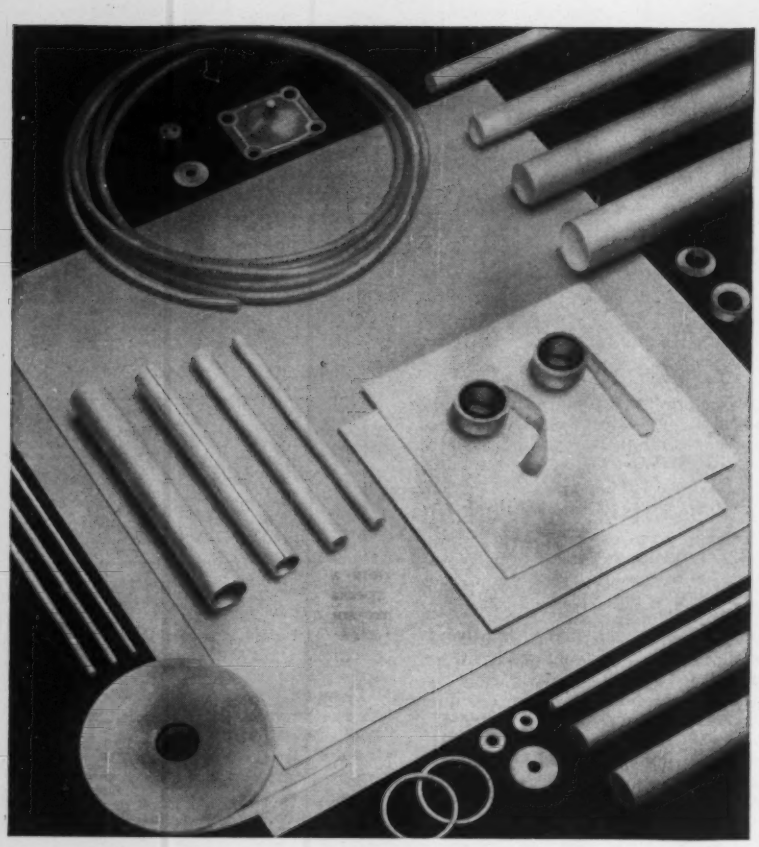
During World War II, the Navy sought an ear plug capable of preventing ear damage and concussion from the tremendous vibration generated by the firing of their big guns. The solution was found in a lead-plastic ear plug. The lead mass keeps the shock wave of sound from moving into the ear en masse. Instead, it lets the pressure of the outside ear build up to meet it gradually . . . slowly enough, in fact, for the shock wave to pass before the pressure inside the ear can become dangerous. The plastic is used to seat the plug in the ear without discomfort. In a quiet environment, a normal speaking voice can be heard through a perforation in the ear plug. Proof of the success of this lead ear plug is attested to by the fact that the Navy is still using them.

Lead Has Many Uses

You'll find lead applications that range from vibration and noise suppression to glazing fine china . . . from swimming pool reactors to superconductivity . . . from corrosion resistant paints to portable reactor shielding. Lead shows a remarkable ability to keep pace with the latest technological developments in a wide variety of fields. Much of this is due to the continued scientific attention devoted by L.I.A. researchers to investigating new uses, techniques, and developments.

For detailed information, write to: *Office of Technical Information, Lead Industries Association, 60 West 42nd Street, New York 17, N. Y.* 1973

LOOK AHEAD WITH LEAD



Now you can do even more with TEFLON — made bondable by R/M

Time was, you'd often rule out "Teflon"* where it was sorely needed, simply because you couldn't make anything adhere to it.

But not now. R/M has perfected a process that makes "Teflon" easily bondable to other materials and to itself with commercial adhesives. Now you don't have to design intricate "Teflon" parts in a single piece or devise elaborate and costly fastening methods.

R/M can supply "Teflon" sheets, rods, tubes, and tape with bondable surfaces where you specify them. Thus you can use the high dielectric strength and superior chemical resistance of "Teflon" without worrying about how to make it stay put. In fact, you can take advantage of bondability and nonbondability in the same R/M "Teflon" part.

A lot is happening in "Teflon" daily. To keep up with it, talk "Teflon" with R/M . . . and learn of R/M's *complete "Teflon" service* that can help you cut product costs without cutting corners. Call one of the offices listed below or write Plastic Products Division, Raybestos-Manhattan, Inc., Manheim, Pa.

*Du Pont trademark for its TFE-fluorocarbon resin

R/M

PLASTIC PRODUCTS DIVISION
RAYBESTOS-MANHATTAN, INC.
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SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS

For more information, turn to Reader Service card, circle No. 424

What's new IN MATERIALS

PROPERTIES OF ALLOY 815-R

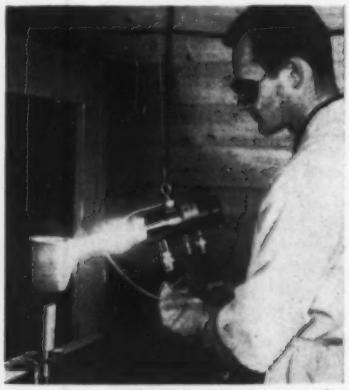
Specific Gravity	7.25
Density, lb/cu in.	0.262
Coef of Ther Exp (68-390 F), per °F	6.5×10^{-6}
Tensile Strength, psi	100-175,000
Elongation (in 10 in.), %	5-25
Elec Res (68 F), ohms/cmf	.815
Temp Coef of Resistivity (—80 to 300 F), per °F	0.10×10^{-5}

recommended for precision wire wound resistors and potentiometers. It is supplied as wire in sizes ranging from 0.0005 to 0.0031 in. in dia. The wire is sold bare or insulated with polyester, polyurethane and other coatings. **KEY NO. 613**

Coatings Applied by Plasma-Arc Technique

Two new plasma-arc spray guns for applying high melting point materials to metals, plastics and other nonmetallics are now on the market. One, called Metco plasma flame spraygun, is available from Metallizing Engineering Co., Inc., Westbury, N.Y. (Key No. 14) The other, called Plasmatron, is available from Giannini Plasmadyne Corp., 3839 S. Main St., Santa Ana, Calif. (Key No. 15)

The plasma-arc principle works by directly transferring the energy from an electric arc to an ionized gas medium, creating temperatures up to 30,000 F. Material passing through the arc is converted into a



Metallizing Engineering Co.

***High temperature** protective coating is applied on a crucible with a plasma-arc spray gun.*

DU PONT IMPROVES

VITON®

SYNTHETIC RUBBER

- NOW GIVES TWICE THE SERVICE LIFE AT 600°F.
- OFFERS GREATER RESISTANCE TO CHEMICALS AND SOLVENTS

VITON'S remarkable resistance to heat and fluids has already improved performance of components for appliances, autos, aircraft and many types of industrial equipment. Now the ability of this new synthetic rubber to withstand heat and chemical exposure has been extended to even greater limits. Here are some of the properties of the new high-performance grade, now commercially available in a wide range of products.

Improved resistance to heat aging—When oven-aged in air at 400° F. or less, VITON vulcanizates now remain usefully elastic for *indefinite periods*. At higher temperatures, they can be expected to remain usefully elastic for more than:

3000 HOURS @ 450° F.
1000 HOURS @ 500° F.
240 HOURS @ 550° F.
48 HOURS @ 600° F.

Improved resistance to fluid exposure—VITON now has better resistance to nitric acid, glacial acetic acid and hydrochloric acid, as well as to certain aromatics and diester lubricants. Its proven resistance to a wide variety of oils, solvents, fuels and chemicals remains unequalled among synthetic rubbers.

Complete information—Learn more about VITON, and how it can improve the products you make and use. Technical literature just published will give you all the facts. Write to E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Dept. ME-2, Wilmington 98, Del.

DU PONT
REG. U. S. PAT. OFF.

SYNTHETIC RUBBER
NEOPRENE HYPALON® VITON® ADIPRENE®

Better Things for Better Living . . . *through Chemistry*

OTHER IMPORTANT PROPERTIES OF VITON

Hardness: 60 to 95 durometer on the Shore A scale.

Tensile strength: 2000 to 3000 psi. at room temperature, with elongation from 100% to 400%, depending on hardness; at 300° F., tensiles of 300 to 1000 psi., with elongation from 80% to 200%.

Compression set: VITON vulcanizates recover to within 90% to 97% of original dimensions when compressed 25% and held at 250° F. for 70 hours.

Low temperatures: Specimens 0.075 in. thick have a Young's modulus of 10,000 psi. at −20° F. and a brittle point of −47° F. A 0.010 in. thick coating of VITON on wire did not crack at −90° F., when bent around a mandrel 10 times the diameter of the wire.

Ozone and weather: VITON has withstood 28 days in 100 ppm of ozone, without a crack! After twelve months' exposure to direct Florida sunlight, it still remained in perfect condition.

Electrical: Typical values—DC resistivity of 1.4×10^{14} ohm-cm; specific inductive capacity of 8.53; power factor of 2.5%; dielectric strength of 412 volts/mil.

For more information, turn to Reader Service card, circle No. 327

For almost every hardness testing requirement

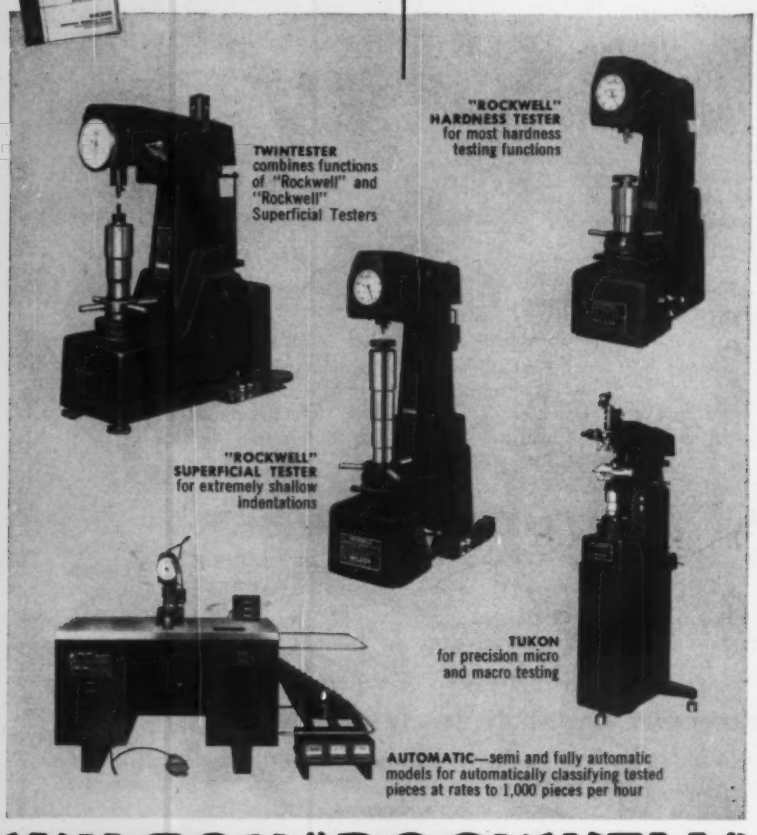
There's a Wilson "Rockwell" instrument to do the job

Wilson "Rockwell" Hardness Testers can help make your products better, stronger, longer lasting. They give reliable results on the production line, in laboratories, in tool rooms, and in inspection departments. They're as easy to use as a center punch, as durable as a machine tool, as sensitive and accurate as a precision balance. That's why Wilson "Rockwell" is recognized as the world's standard of hardness testing accuracy.

Wilson "Brale" Diamond Penetrators give Perfect Readings

A perfect diamond penetrator is essential to accurate testing. Only flawless diamonds are used with Wilson "Brale" penetrators. Each diamond is cut to an exact shape. Microscopic inspection and a comparator check of each diamond—one by one—assure you of accurate hardness testing every time.

Write for Catalog RT-58. It gives complete details on the full line of Wilson hardness testing equipment.


TWINTESTER
combines functions of "Rockwell" and "Rockwell" Superficial Testers
"ROCKWELL" HARDNESS TESTER
for most hardness testing functions
"ROCKWELL" SUPERFICIAL TESTER
for extremely shallow indentations
TUKON
for precision micro and macro testing
AUTOMATIC—semi and fully automatic models for automatically classifying tested pieces at rates to 1,000 pieces per hour

WILSON "ROCKWELL" HARDNESS TESTERS

ACCO

Wilson Mechanical Instrument Division
American Chain & Cable Company, Inc.
230-E Park Avenue, New York 17, New York

For more information, turn to Reader Service card, circle No. 354

fluid and deposited on a part at high speeds.

Metallizing Engineering says its plasma-arc gun will spray any material that melts without decomposing. For example, the gun can apply coatings of such high melting materials as tungsten, zirconium carbide, columbium carbide, zirconium boride and tungsten carbide. The gun develops normal work temperatures of 10,000 to 15,000 F, and operates on inexpensive gases such as nitrogen and hydrogen. It is designed for push button operation, according to the producer.

Giannini Plasmadyne's gun is a "hand held" device weighing less than 4 lb and measuring 3½ in. long. It operates on gases such as argon and nitrogen. According to the producer, practically any material that melts can be sprayed with the gun.

KEY NOS. 614, 615

Metals Cleaned, Primed Painted in One Unit

A safe, fast method for cleaning, phosphatizing and painting metals in one machine without the use of water will be commercially available in mid-1960. The system, first announced last year (see M/DE, Jan '59, p 140), is now operating on a field trial basis at several plants.

It was developed by the Electrochemicals Dept. of E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del. in cooperation with G. S. Blakeslee & Co., 1900 S. 52nd Ave., Cicero, Ill., which designed and fabricated the equipment.

How it works

In the new process, metal parts are first degreased in a vapor of noninflammable trichlorethylene solvent, then given a phosphate coating by dipping or spraying with a trichlorethylene-base phosphatizing solution maintained at its boiling point (188 F). After phosphatizing, the solvent evaporates, leaving parts

SOURCES of most engineering materials can be found in the third edition of M/DE's *Materials Selector* reference issue, published last October. Properties of all materials are also given.

New steels are born at Armco

Tank head (top), bracket (bottom), and control valves (center) illustrate the great workability of Armco ZINCGRIP.

Brady cuts costs, simplifies design, speeds assembly, improves performance with Armco ZINCGRIP Steel

Rust resistance of Armco ZINCGRIP® Steel helps water pressure tanks and controls manufactured by Brady Air Controls, Inc., Muncie, Indiana, provide the trouble-free service home owners want. Workability of this special hot-dipped, zinc-coated steel also means cost-cutting production advantages, especially in fabrication of air volume control valves.

ZINCGRIP replaces die-castings

Originally, valves were two cup-shaped die-castings, joined by bolts, with a diaphragm between them. Now halves are formed from ZINCGRIP Steel and the diaphragm inserted. Both parts are then securely locked together by a reverse draw that creates an airtight seal. Rust is sealed out, too, because ZINCGRIP's tight coating does not flake or peel despite this severe fabrication.

One ZINCGRIP valve replaces any of four die-cast models. It can be assembled faster, performs better and costs less than all those it replaces.

Offers savings

You, too, can cut costs and increase your product's sales power with Armco ZINCGRIP. Its zinc coating stays intact through severe working for many corrosion-resisting applications where more costly or hard-to-fabricate materials are now used. Mail the coupon today for more information.

ARMCO STEEL CORPORATION
1040 Curtis Street, Middletown, Ohio

Please send more information on Armco ZINCGRIP Steel

Name_____ Title_____

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City_____ Zone_____ State_____

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation

For more information, turn to Reader Service card, circle No. 323

IS IN REYNOFOAM* PRODUCTION

On the Reynofoam production lines at Reynolds Chemical Products high speed production combines with close, personal attention to detail . . . strict, knowledgeable inspection of the finished product . . . rigid quality control. For the customer, this means *lower* cost . . . higher quality.

These are requisites that every Urethane Foam user must seek—and they can be combined only where proved ability goes hand-in-hand with consistent performance.

Reynofoam, an exclusive product of Reynolds Chemical Products Company can be molded to your precise specifications and delivered to you with time, quality and cost considerations that are sure to please you.

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DIVISION OF STUBNITZ GREENE CORP.

For more information, turn to Reader Service card, circle No. 432

What's new IN MATERIALS

dry and ready for immediate painting.

The phosphate coating, as formed on steel, is a strongly adherent form of iron phosphate which provides a good paint base. Du Pont says phosphate coatings can also be produced on other metals such as aluminum, magnesium and zinc.

The final stage of the process is the application of trichlorethylene-thinned paint to the treated metal. In general, any paint ingredient that is soluble in trichlorethylene, such as certain alkyd resins, epoxies, acrylics, asphaltic materials and chlorinated rubbers can be used in formulating trichlorethylene-thinned paints. The paints can be pigmented, and may be decorative as well as protective in nature.

Advantages of system

C. B. Shepherd, manager of Du Pont's Chlorine Products Div., says: "Significant solvent economies can be realized when phosphatizing is combined with vapor degreasing since degreasing and phosphatizing together use very little more solvent than does degreasing alone." This combination, he says, requires much less equipment to clean and phosphatize metal parts and occupies much less floor space than conventional wet systems.

Shepherd says ". . . even greater savings can be achieved when painting is added to degreasing and phosphatizing." The painting system is said to slash costs because thinner and paint overspray are recovered and reused in the machine.

The trichlorethylene finishing system can be used alone or incorporated separately into existing wet systems. KEY NO. 616

Synthetic Rubber Latex Better Than Natural

Development and volume production of a new synthetic rubber latex, said to produce a lighter, whiter foam with resistance to aging twice that of foam made from natural rubber latex, was announced recently by Goodyear Tire & Rubber Co., Akron 16, Ohio. At the same time, the company's Foam Products Div. announced that it is converting entirely

Formula for Success

The formulation of a stainless steel alloy requires as much precision as any chemical compound. All the care exercised in the selection of a particular alloy can be nullified by variations in the analysis specified.

During fabrication, for example, slight differences in chromium-nickel: carbon ratios can cause changes in microstructure which lead to early failure.

That's why it is safer to specify J&L Consistent Quality Stainless Steel. J&L leads the industry in melt shop standards for stainless steel—the point where quality starts, **and longer service life begins.**

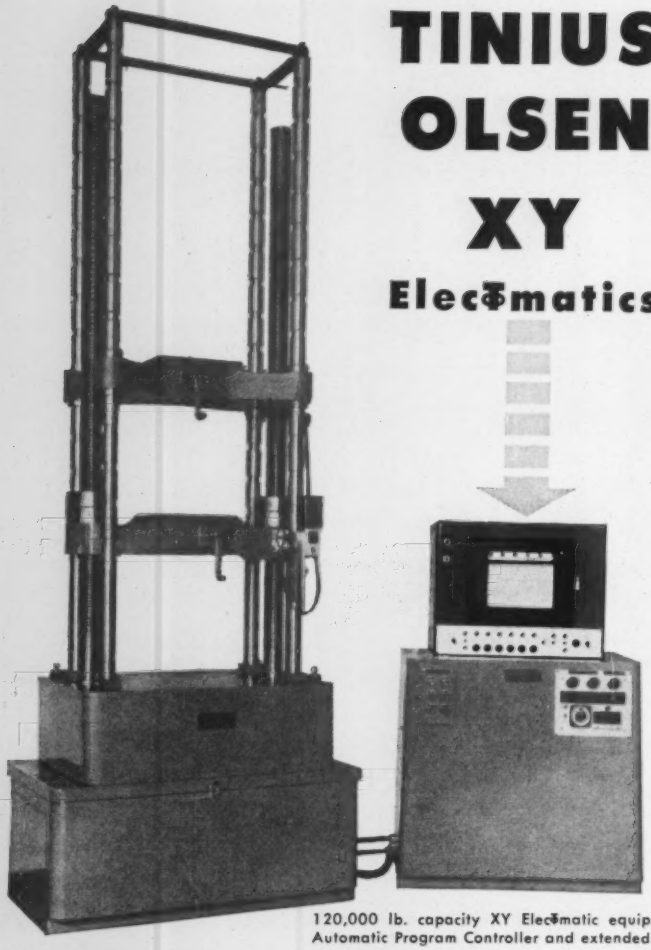
J&L
STAINLESS
SHEET • STRIP • BAR • WIRE

Plants and Service Centers:
Los Angeles • Kenilworth (N. J.) • Youngstown • Louisville (Ohio) • Indianapolis • Detroit

For more information, circle No. 410

Jones & Laughlin Steel Corporation • STAINLESS and STRIP DIVISION • Box 4606, Detroit 34

TINIUS OLSEN XY ElecTmatics



120,000 lb. capacity XY ElecTmatic equipped with Automatic Program Controller and extended columns.

HAVE NO CAPACITY LIMIT

Originally conceived for testing such low tensile materials as plastic films, fibers, etc., the inherent versatility of Tinius Olsen XY ElecTmatics to 12,000 lbs. has sparked a demand for higher capacity models. Testing engineers throughout industry have grasped the unmatched advantages of the Olsen XY strip chart recorder and the wide variety of testing functions this machine performs.

A minimum of eight testing ranges of as little as 1/200 capacity are built into the machine and are available at any time with the flip of the range selector switches. Any testing speed may be dialed and held constant under load by the variable speed motor drive. Testing stroke is unlimited.

Coupled with Olsen strain instrumentation, accurate stress-strain curves can be made for any material, no matter how fragile. Automatic program controls further extend the variety of vital testing procedures, including stress, strain or crosshead cycling.

Write today for full information on the incomparable line of Tinius Olsen XY ElecTmatics—now available in any capacity to suit your testing requirements.

TINIUS OLSEN
TESTING MACHINE COMPANY
2010 EASTON ROAD • WILLOW GROVE, PA.
Testing and Balancing Machines

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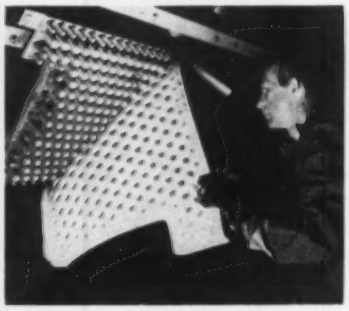
For more information, turn to Reader Service card, circle No. 456

What's new IN MATERIALS



***Stripping molded cushion** made of a new synthetic latex from a curing mold.*

to the new latex in the manufacture of cushioning materials.

The latex, called Pliolite 5352, will be marketed at 20 to 30% under the price of natural latex.

Composition, properties

Goodyear says composition of its synthetic latex closely resembles that of natural rubber latices. The latex is also said to contain less than half the non-rubber materials found in other synthetic rubber latices.

Laboratory tests show that germicidal and fungicidal properties are considerably better than in any other cushioning or foam material. Excellent compression, resilience and durability, as well as good flex life, are other advantages of foam made from Pliolite 5352, according to Goodyear.

KEY NO. 617

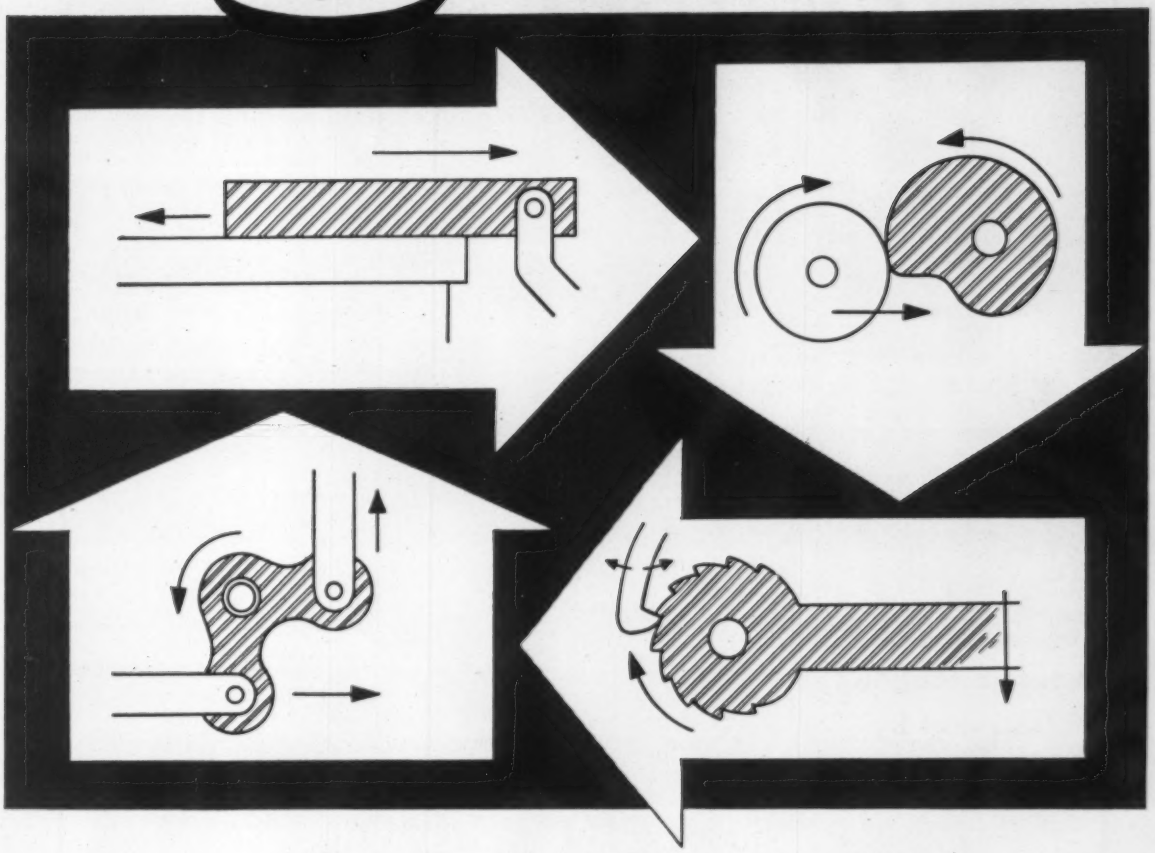
Permanent Magnet Has High Energy Value

What is claimed to be the first commercial permanent magnet with an energy value of seven million is now available on a production basis from Indiana Steel Products Co., Valparaiso, Ind.

The new permanent magnet material, called Hyflux Alnico V-7, has a residual induction (B_r) of 12,750 gausses and a coercive force (H_c) of 765 oersteds. It is expected to be used for ground and airborne generators and alternators, meters, recording instruments, oscillographs, magnetometers, galvanometers and guidance equipment.

The Alnicos are dispersion-hardened alloys, consisting basically

V-R METALS...



...for Design Wearability

If it slides on a surface . . . rolls on a shaft . . . makes interrupted contact . . . turns on a pivot . . . or performs any other function involving wear . . . you can rely on V-R metals to help solve your wear-part problems.

Extreme resistance to wear is just one of the valuable characteristics of metals that V-R makes available to the designer. It will also pay you to contact V-R whenever parts of your equipment require corrosion resistance . . . high density . . . stability at extreme temperatures . . . rigidity under a given load . . . good surface finish . . . and low coefficient of expansion for greater dimensional uniformity.

These properties can be produced in various combinations in sintered or alloyed metals to fill your specific needs . . . just send us the details of your requirements.

V-R VASCOLOY-RAMET

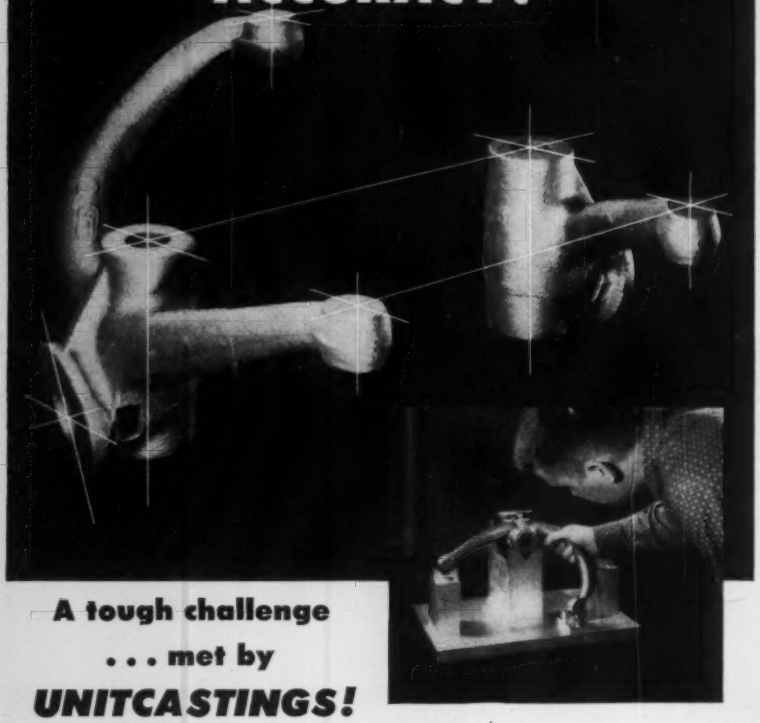
CREATING THE METALS THAT SHAPE THE FUTURE

A-761

840 Market Street · Waukegan, Illinois

For more information, turn to Reader Service card, circle No. 401

FOUR DIMENSIONAL ACCURACY!



A tough challenge . . . met by UNITCASTINGS!

Four-way specifications for this pair of steering arms combined tolerances difficult to hold in sand casting. Structural contour, surface limitations and internal consistency are accepted with regularity at Unitcast. However, a fourth requirement, *relationship of extremities* in such an unusual casting design is a tough problem to solve *economically!*

With a reasonable *finished* cost as an objective, Unitcast's quality control specialists recommended an unorthodox molding method. Special pattern equipment was built to control distortion in the spider-like arms . . . metal flow was redirected along with other unusual procedures. Finally, inspection jigs assured delivered accuracy.

Unitcastings *more* than meet customer's requirements and *cost remained competitive!* Unitcast can offer a similar service for your problems . . . call today for a Unitcast Sales Engineer.

UNITCAST CORPORATION, Toledo 9, Ohio
In Canada: CANADIAN-UNICAST STEEL, LTD., Sherbrooke, Quebec

Unitcast

SPECIFICATION STEEL CASTINGS

For more information, turn to Reader Service card, circle No. 393

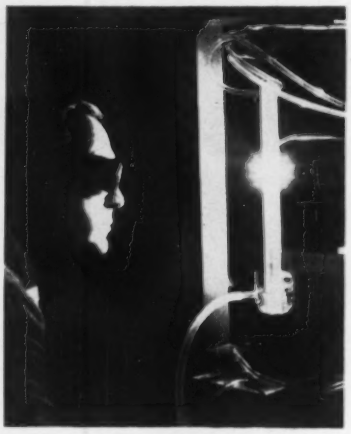
What's New IN MATERIALS

of aluminum, nickel and iron, with some cobalt, copper or titanium added. The alloys are all hard and brittle, and are fabricated by casting and grinding. KEY NO. 618

Clarity of Polyethylene Improved by Annealing

The optical properties of polyethylene film have been substantially improved with the aid of an inexpensive annealing chamber that raises the frost line of film being extruded.

Devised by technicians at U. S. Industrial Chemicals Co., Div. of National Distillers & Chemical Corp., 99 Park Ave., New York 16, the technique is most effective when ex-



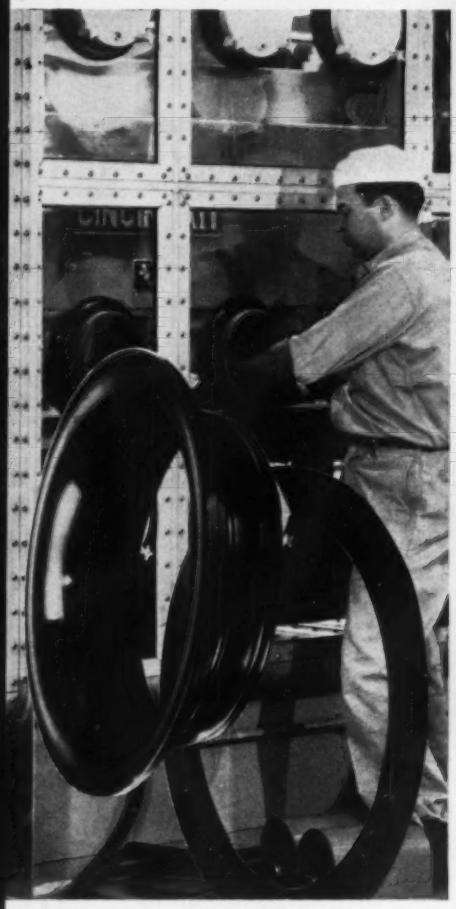
Zone melting boron—A new zone melting method turns out boron crystals larger than any previously available. Crystals as large as 0.1 in. in dia have been made. The technique was developed by E. S. Greiner of Bell Telephone Laboratories, 463 West St., New York 14.

Boron powder is first placed in boric acid and boiled to dryness. The resulting boric acid-coated powders are pressed into bars that can be handled without breaking.

A high frequency coil like the one shown here is used to melt a narrow zone of the coated boron bar. The molten zone is moved down the rod by raising the bar through the coil while the melted boron crystallizes above the coil. KEY NO. 619

For more information, circle No. 437 ➤

Product-Design
BRIEFS
from Durez



ARGONNE NATIONAL LABORATORY

PHENOLIC PORTHOLES? WHAT NEXT!

Atomic engineers have found a good way to seal those big gloves that handle plutonium and its deadly cousins in inert-atmosphere chambers.

The port you see here does this critical job well. It is compression molded of a Durez medium-impact phenolic. It doesn't leak. It also resists shock, corrosion and heat. Its smooth surface won't snag the rubber glove. And it is economical: metal inserts can be molded right in. Except for polishing off flash, it's all finished when it comes off the press.

Have *you* looked into atom-age phenolics lately? They're better, more versatile than ever. To see what they can do for you, check the coupon for our Bulletin D400. It lists properties, uses, advantages of many interesting Durez compounds.

PUT THE BRAKES ON HEAT

No, this isn't a magic powder you sprinkle on a product to make it resist heat. It is a material—Durez phenolic resin—that's used in scores of products as a *bonding agent* to impart controlled degrees of heat resistance.

Brake linings are just one example. Some others: electronic resistor coatings, shell molds and cores for foundry use and automotive generator brushes.

For heat resistance at low cost, you just can't beat phenolic resin. If you have such an application, write us the details and we'll gladly try to help you as we have helped many others.

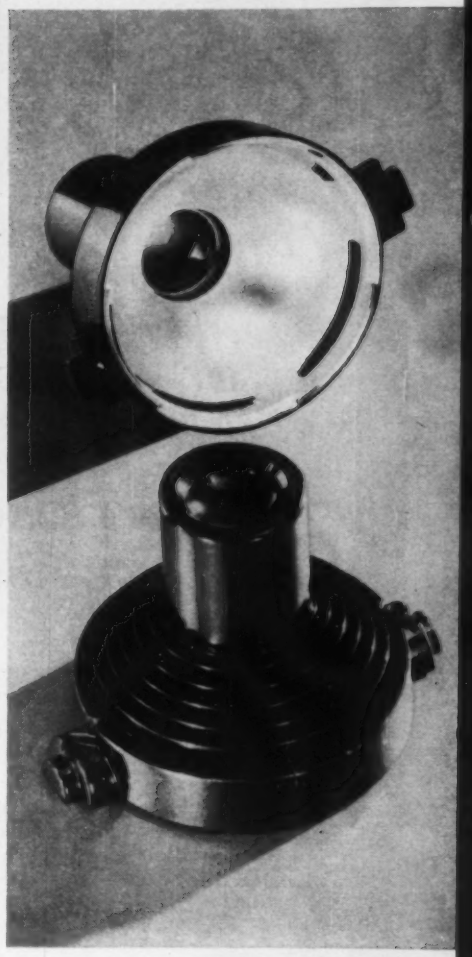
BRIGHT IDEA: PLASTIC-METAL MIRROR

Metallized phenolic saves a costly production step in this housing for a microscope lamp.

In place of a custom-made reflector, the molded phenolic housing has an aluminum mirror deposited right on it by vacuum metallizing.

The Durez compound chosen for this part has the right surface for metallizing, and incorporates high impact strength, low thermal conductivity.

You'll find many helpful ideas like this in *Durez Plastics News*, special bulletin mailed periodically to thousands of product-design men. A check mark on the coupon will bring *News* to you faithfully.



For more information on Durez materials mentioned above, check here:
☐ Phenolic molding compounds—descriptive Bulletin D400 ☐ Phenolic resins—illustrated bulletin describing uses ☐ *Durez Plastics News*—mailed periodically
Clip and mail to us with your name, title, company address. (*When requesting samples, please use business letterhead.*)

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For more information, turn to Reader Service card, circle No. 364

What's new IN MATERIALS

Polyethylene film *produced by annealing (right) is clearer than conventional film (left).*

OPTICAL PROPERTIES OF FILM

Type →	Conventional	Annealed
Transmittance, %	30	70
Gloss, %	7	11
Haze, %	11	4

truding resins that have a narrow molecular weight distribution. U.S.I. technicians found that height of the annealing chamber is a critical factor in obtaining optimum film properties; best results are achieved in a chamber measuring between 6 and 10 in. in height. Mechanical operations must be closely controlled, since the raised frost line tends to make the film wrinkle.

The clear film is expected to be used for packaging hardware, produce, toys and some foodstuffs.

KEY NO. 620

Control Improves Resistance Welds

Resistance spot welding may now be used for a greater variety of materials and products because of a new automatic feedback control called Monautronic. The device was developed by the Electronic Controls Section of Budd Co., Philadelphia 32.

Advantages of method

The developer says broader use of resistance welding is possible with the new control for the following reasons:

1. Uncertainty as to weld strength is eliminated.
2. Costly inspection during production is not required.
3. Redundant welding is stopped.
4. Destructive testing of welds is not required.

Resistance welding techniques us-

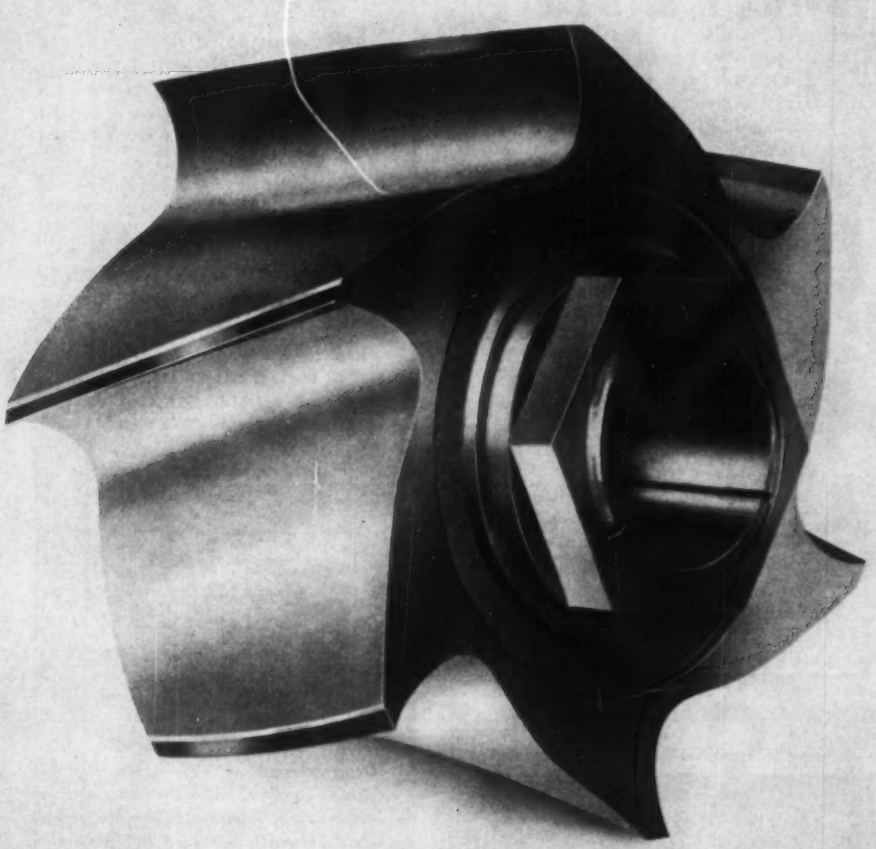
For more information, circle No. 378 ➤

NOW: Higher strength costs you less! Specify TENZALOY*, the self-aging aluminum alloy that needs no heat treatment! TENZALOY is a corrosion resistant aluminum alloy that ages at room temperatures, gives high strength properties superior to those normally obtained only by solution treating, quenching and artificial aging. And these properties are stable, proved by conclusive test data taken over a ten year period. No special foundry techniques are required. No fluxes. Castability is excellent with sand cast and plaster molds, and many permanent molds. TENZALOY will not "grow". It takes a brilliant polish and anodizes clear white. Write for TENZALOY Bulletin No. 103 or call one of Federated's 22 sales offices. Federated Metals Division, 120 Broadway, New York 5. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.

FEDERATED METALS DIVISION OF

ASARCO

AMERICAN SMELTING AND REFINING COMPANY



**TENZALOY is one of a complete range of Federated aluminum casting alloys. These and hundreds of other quality controlled non-ferrous metal products are produced in the 11 plants of the Federated Metals Division.*

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Our equipment is such that tolerances can be held to as low as 3% (plus or minus), as compared to the A.I.S.I. maximum allowable variation of 10%. This "Thinness Control" means the ability to control decimal thickness with micro-accuracy, giving you more stainless area per ton or the equivalent area with less weight. It is this controlled accuracy and uniformity that directly relates to fabricating economies and satisfaction in the ultimate end use.

MicroRold Stainless Steel Sheet is available in widths up to 36" in gauges from .005 to .109, and in widths up to 48" from .010 to .109 in all commercial grades, finishes and tempers. MicroRold Strip can be supplied in widths up to 23 15/16" in gauges from .010 to .109, and VERI-THIN Strip as thin as .0015 to .009 in all commercial strip finishes.

Distributed by steel warehouses throughout the world!

Send for your copy of "MicroRold Stainless Steel Handbook"

WASHINGTON STEEL CORPORATION

WOODLAND AVENUE • WASHINGTON, PENNSYLVANIA

For more information, turn to Reader Service card, circle No. 362

What's new IN MATERIALS

ing the control may replace other welding and fastening techniques in applications where consistency in weld strength is required.

Many metals can be welded

Any metal that can be resistance welded can probably be welded with the new control. Metals welded by Budd Co. include: stainless, low carbon and carbon-molybdenum steels; galvanized iron; nickel-base alloys; and titanium.

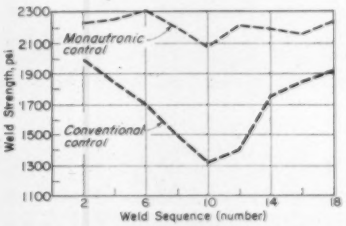
Tests indicate that such metals as beryllium, columbium, tantalum, molybdenum, vanadium and zirconium—to the extent that such metals can be welded under carefully controlled conditions—can be welded better with the Monautronic control than with any other welding control.

The developer says an airframe manufacturer has successfully used the control to weld stainless steels, titanium alloys and nickel-base alloys. According to the airframe manufacturer, the control produces welds of consistently higher strength and quality than welds made on the same materials with a conventional welding control.

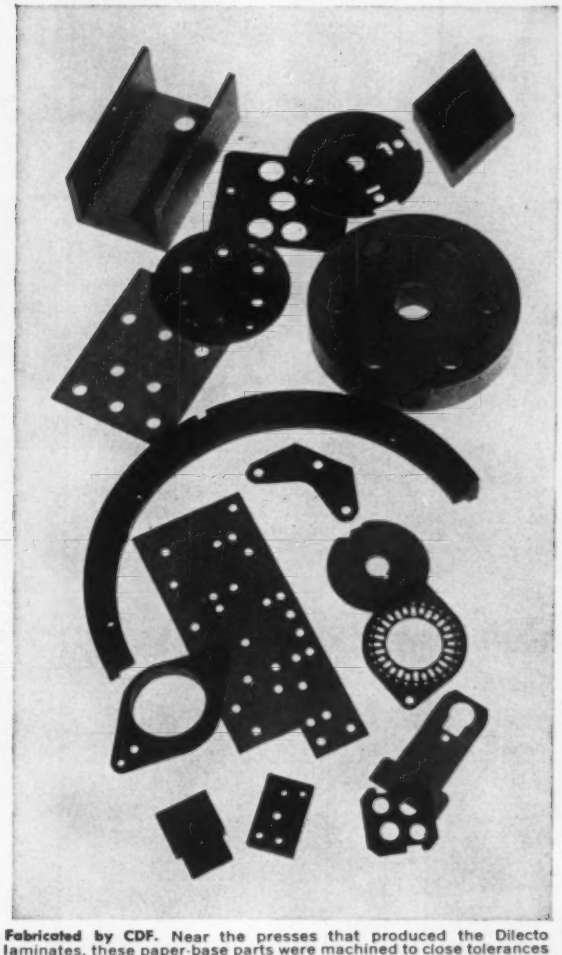
Resistance welding of galvanized iron and vinyl-clad steel, previously considered very difficult because of the varying and inconsistent electrical effects of the coatings, can be done safely and easily with the new control, according to the developer.

How it works

The control compensates automatically for variations in line voltage, applied force, electrode wear, variations in surface finish, fit, shunting effect, contamination, variations in



***Comparison** of weld strengths obtained with a Monautronic and a conventional control. The minimum weld strength specified by Budd Co. is 1400 psi. Welds were made on a tailgate assembly.*



Fabricated by CDF. Near the presses that produced the Dilecto laminates, these paper-base parts were machined to close tolerances by CDF specialists . . . quickly, accurately, economically for the purchasers. This is a random selection from the five grades described in the table below.

Low-cost insulation problems? Look into these CDF Dilecto® laminates

For everyday mechanical-electrical parts that receive tough punishment and must have excellent physical and dielectric properties at low cost, the CDF phenolic paper-base line is outstanding.

Economy. CDF paper-base grades machine readily into intricate parts. Some are flame-retardant. Others are especially adaptable for punching. All are economical for the value delivered.

Fabrication Facilities. CDF has excellent and extensive plastics-fabrication facilities for turning out finished Dilecto parts to your specifications—better and more economically than you can do it yourself. Save the time and trouble of intricate fabrication by using CDF's specialized facilities.

See Sweet's, Electronics Buyers' Guide, and the other directories for the phone number of the CDF sales engineer nearest you. Or send us your print or problem direct, and we'll return a recommendation of the right Dilecto grade for your need.

CDF makes Di-Clad® printed-circuit laminates, Diamond® Vulcanized Fibre, CDF products of Teflon†, flexible insulating tapes, Dilecto® laminated plastics, Celoron® molded products, Micabond® mica products, Spiral Tubing, Vulcoid®.

†Du Pont trademark for its TFE-fluorocarbon resin

CONTINENTAL-DIAMOND FIBRE

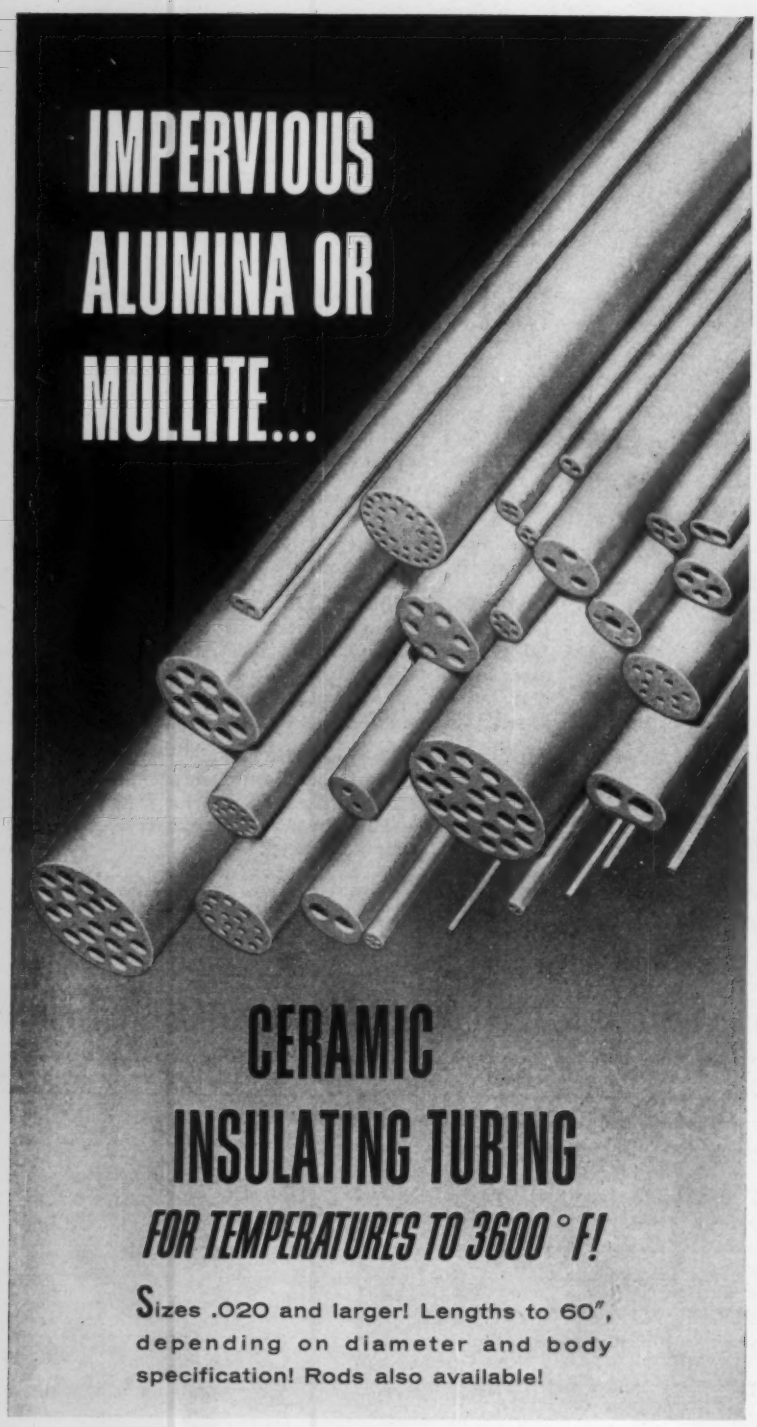
A SUBSIDIARY OF THE Bakelite COMPANY • NEWARK 25, DEL.

In Canada: Continental-Diamond Fibre of Canada Ltd., 46 Hollinger Road, Toronto 16, Ont.

Typical Property Values—Dilecto Paper-Base Laminates in Sheet Form

	X-13 (NEMA X)	XP-13 (NEMA P)	XX-13 (NEMA XX)	XX-13 FR (Fire-retardant) (NEMA XX)	XXXP-28 (NEMA XXXP)
ROCKWELL HARDNESS (M SCALE)	100	95	110	108	90
TENSILE STRENGTH lw (1000 psi.)	20	12	16	17	12
FLEXURAL STRENGTH lw (1000 psi.)	27	16	17	20	18
COMPRESSIVE STRENGTH (1000 psi.)	40	25	35	41	22
WATER ABSORPTION (% in 24 hrs.) 1/16" thickness	3.5	3.0	1.4	1.2	0.6
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (°C.)	120	120	120	120	120
DIELECTRIC STRENGTH perp. to lam. (VPM)	800	800	650	700	800
DIELECTRIC STRENGTH parallel to lam. (Kv.)	50	50	60	70	75
DISSIPATION FACTOR at 1 mc, Cond. A	0.042	0.038	0.034	0.038	0.027
DIELECTRIC CONSTANT at 1 mc, Cond. A	5.5	4.6	4.7	4.8	3.6
ARC-RESISTANCE (seconds)	8	4	4	10	10
INSULATION RESISTANCE (megohms) ASTM D-257, Fig. 3	100	100	1,000	1,000	600,000
AIEE insulation class	A	A	A	A	A

For more information, turn to Reader Service card, circle No. 451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BEAVER FALLS · PENNSYLVANIA

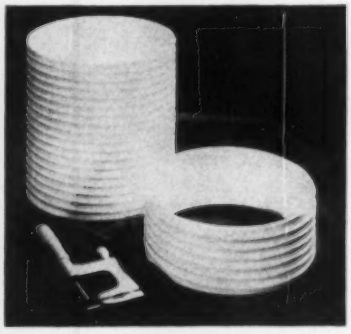
For more information, turn to Reader Service card, circle No. 379

What's new IN MATERIALS

electrode length, and variations in thickness and hardness of metals to be welded.

The control obtains a correct fusion temperature within each weld by 1) relating the voltage across each weld area to the ultimate temperature that will occur within the weld, and 2) measuring the actual voltage at the weld electrodes and comparing this value to a command voltage which has previously been programmed into the control. The device will "lock-out" and no weld will be made if conditions develop beyond its range of control.

KEY NO. 621



***Ceramic shapes** are made to close dimensional tolerances by new forming, firing and grinding techniques.*

Ceramic Cylinders Are Thin-Walled, Large

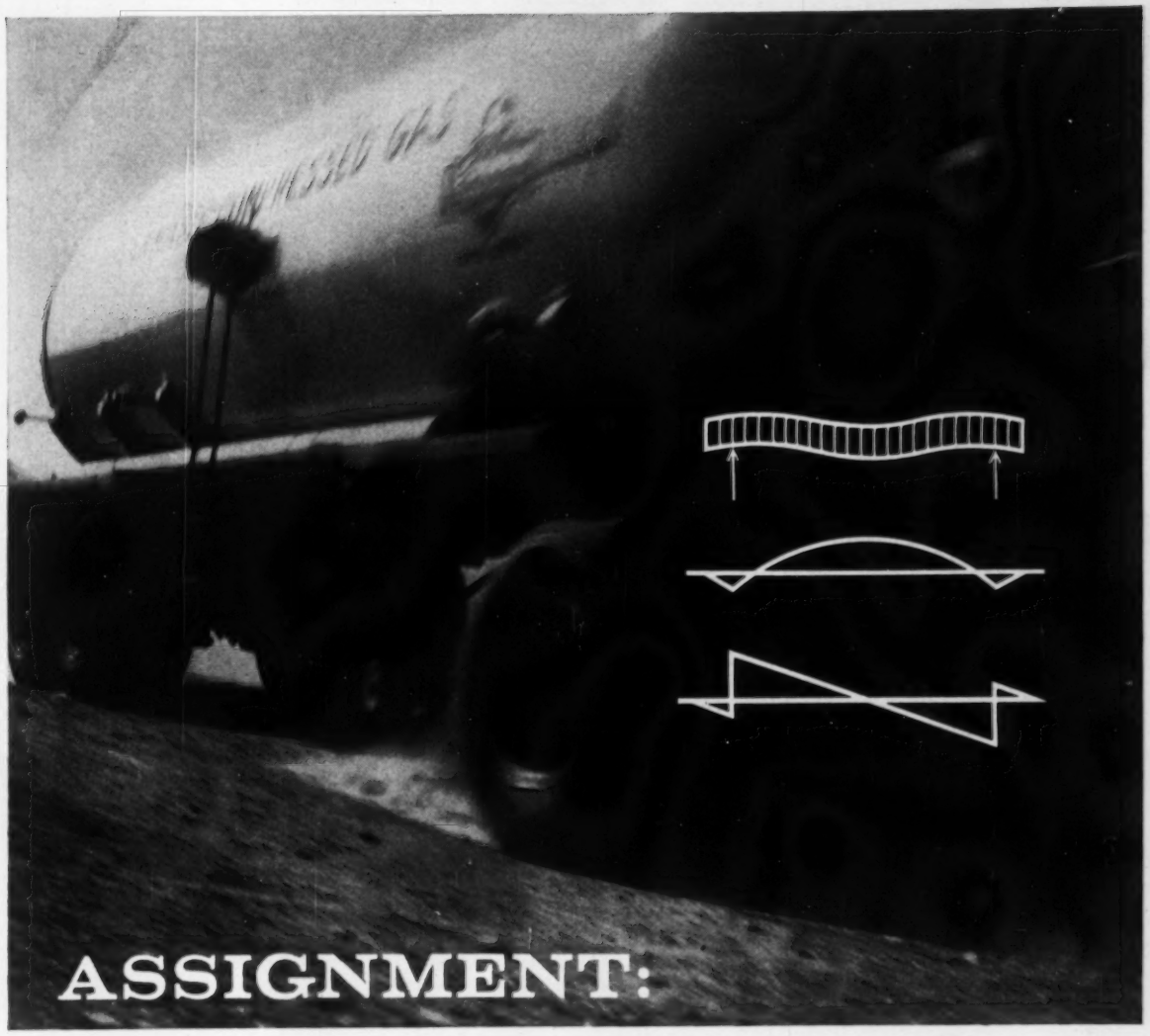
New forming, firing and grinding techniques developed by Centralab Div., Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis. are said to permit the fabrication of extremely thin-walled, large diameter ceramic cylinders for use as coil forms, pistons and other applications.

KEY NO. 622

Magnesium Sheet Can Be Bent Cold

A new magnesium sheet can be bent up to 90 deg at room temperature without cracking. Thus heated dies can be eliminated in many cases, according to the producer.

Guaranteed bend factors for the magnesium sheet range from 2.0 t to



STRENGTH/WEIGHT

How Lukens *Application Research* can help you find the right steel plate for the job

Designing for maximum payload means taking maximum advantage of today's high strength steels. Experts who know these steels—from a practical as well as technical standpoint—can give invaluable assistance in the early planning stages. This is the job of our Application Engineering staff.

LPG transport tanks and power shovels are widely divergent areas in which Lukens engineers have helped increase payloads.

The use of Lukens "T-1" steel plate and heads in tanks for hauling LP-Gas has fostered an entirely new design concept in the tank truck field. This high tensile, high yield strength steel (100,000 psi) makes it possible to mount wheels *directly on the tank.* The dead weight of heavy underframes goes into payload.

Working with a major producer of power shovels, our staff suggested tough Lukens "T-1" for buckets, dipper sticks, bucket teeth and other key parts. Lightweight, welded steel plate—rather than heavy castings—added as much as 40% to load capacity.

From these successful projects—and many more—our Application Engineers have gained knowledge and experience of value to design engineers. That's why we say... *if your assignment is strength/weight, let it be our assignment, too.* Contact Manager, Application Engineering, D-20 Services Building, Lukens Steel Company, Coatesville, Pa.

Helping Industry Choose Steels That Fit The Job

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ASK FOR THE LUKENS "T-1" STEEL BULLETIN

For more information, turn to Reader Service card, circle No. 334

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THE SCOTT MODEL CRE Constant-Rate-of-Extension Tester offers you the ultra-high accuracy of inertialess electronic weighing . . . *plus* effortless automatic operation that takes the work and weight handling out of physical testing! At a touch, the simple finger-tip controls of the Model CRE provide a variety of crosshead speeds, complete crosshead control and a wide range of test capacities . . . enabling even the non-technical operator to obtain detailed test results faster, easier, and *at amazingly low cost!*

VERSATILITY is another time-and money-saving feature of the Scott CRE Tester. This simple yet super-sensitive tester is designed for use with Scott's more than 150 different clamps and holding fixtures to meet ASTM, ISO and Industry Test Methods and material requirements. Moreover, Model CRE can be set up quickly for tensile, tear, adhesion, burst, seam construction and many other physical tests . . . with ranges from the lowest up to 1000 lbs. or 500 kgs.

FOR PRODUCT DEVELOPMENT, QUALITY CONTROL, and countless other tests that make the difference between profit and loss . . . you can be sure *your* product's qualities meet industry standards, when you make the sure test . . . Scott!

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SCOTT TESTERS
THE SURE TEST . . . SCOTT!

For more information, circle No. 471

What's new IN MATERIALS

GUARANTEED BEND FACTORS FOR MAGNESIUM SHEET*

Sheet Thickness, in.	Perpendicular	Parallel
0.040-0.100....	2.0 t	2.5 t
0.101-0.190....	2.5 t	3.0 t

*Factors are based on acceptance testing procedures using 6-in. wide specimens in a press brake with steel mandrels and a rectangular retaining die.

3.0 t depending on sheet thickness and direction of bend (see accompanying table).

The product, designated "special bending sheet," is now available from Dow Metal Products Co., Div. of Dow Chemical Co., Midland, Mich.

The special bending sheet is produced from coils of AZ31B-O alloy. The sheet has a lower tensile yield strength than standard AZ31B-O sheet, but still meets the requirements of federal specification QQ-M-44, Dow says. Drawability of the two types of sheet is said to be essentially the same.

Dow attributes availability of its special bending sheet to improved coil rolling techniques. Previously, magnesium cold-bending sheet was produced only on hand mills.

Diamonds Are Tailored for Grinding, Polishing

Man-made industrial diamonds, first announced in 1955 (see *Materials & Methods*, Apr '55, p 12) and commercially available since 1957 (M/DE, Dec '57, p 178), can now be tailored for special cutting, grinding and polishing applications. This is done by controlling their shape and other characteristics in manufacture, according to General Electric Co., Schenectady, N. Y.

In making diamonds, carbon and a catalyst metal are subjected simultaneously to pressures ranging from 800,000 to 1,800,000 psi, and to temperatures ranging from 2200 to 4400 F.

GE says the shape of the diamond crystal varies according to the temperature of formation. Cubes predominate at the low end of the critical temperature range; mixed cubes,

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*temperature indicating crayons**

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***Tempilstik°*—a simple and accurate means of determining preheating and stress relieving temperatures in welding operations. Widely used in all heat treating—as well as in hundreds of other heat-dependent processes in industry. Available in 80 different temperature ratings from 113°F to 2500°F . . . $2.00 each.**

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Most industrial and welding supply houses carry Tempilstiks° . . . if yours does not, write for information to:

INDUSTRIAL DIVISION

Tempil° CORPORATION
132 West 22nd St., New York 11, N. Y.

For more information, circle No. 439

FRASSE ALUMINUM

helps tell how she's doing!

Ballistic missile success hinges on intelligence obtained in test firings. Tracking data – reporting velocity, direction, altitude, temperature, etc. is vital – when processed, it guides critical design changes.

Heart of the intricate data processing system at Cape Canaveral is a Potter Magnityper – a high speed electronic printer that decodes raw material . . . then stores, collates, interprets and prints at 72 *thousand* characters per minute. Lightweight, non-magnetic aluminum is essential to its efficient operation – that's why the Magnityper is made almost completely of Frasse aluminum.

Frasse ships the required sizes quickly from stock – in the grades that contribute to its ease of fabrication *and* performance. For example, Frasse supplies 2024-T4 bars for *strength* and *machinability*, 5052-H34 sheet for *formability* and *weldability* and "775" tooling plate for *dimensional accuracy* with *no distortion when worked.*

Perhaps these same qualities can increase the efficiency of *your* product – or reduce fabricating costs. It's worth investigating – and a Frasse aluminum specialist will be glad to help. There's no obligation – simply write or call your nearest Frasse office. You'll be glad you did.

Call FRASSE for ALUMINUM

Screw Machine Stock • Bars • Rods • Wire Sheets • Plates • Tubing • Holobar Pipe • Fittings • Valves • Extrusions Tool and Jig Plate

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For more information, turn to Reader Service card, circle No. 373

DALIC SELECTIVE PLATING for ELECTRONIC COMPONENTS

Plating circuit contacts without dismantling electronic components.

Quick Accurate Way to Plate:

- Semi-Conductors.
- Flexible Circuits.
- On site field repair of Electronic Computer Contacts.

Speeds Production in:

- Automatic plating of Transistor Tabs.
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Plate selected areas rapidly without disassembling components. Dalic Process accurately controls thickness of deposits. Produces quality plating.

No Immersion Tanks. Mobile Equipment.

Plating equipment can be moved to the job. Quick, easy to use with Dalic hand-stylus, power pack, and the Dalic plating solutions. Mechanized production can be devised.

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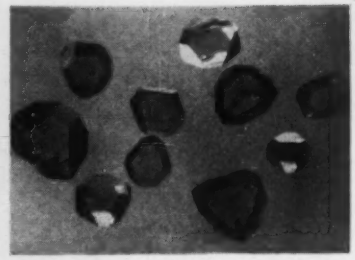
For more information, circle No. 339

What's new IN MATERIALS



Man-made diamonds *can be tailored for cutting, grinding and polishing applications.*

cubo-octa-hedra, and do-decahedra at the intermediate point; and octahedra at the upper limits of the range.

GE, in releasing new data on materials used in diamond manufacture, says that best results are obtained when pure graphite is used as the starting material. The data, until now a secret, also shows that the catalyst metal can be chromium, manganese, iron, cobalt, nickel, ruthenium, rhodium, palladium, osmium, iridium, platinum or tantalum.

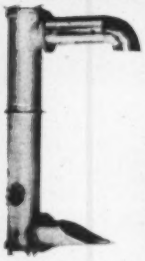
KEY NO. 624

Wood Grain Texture for Molded Plastics

A wood grain texture for molded plastics parts has been developed by Dow Chemical Co., Midland, Mich. The texture is formed by special techniques in the molding of expand-

Molded plastics container *shows flow pattern of wood grain texture.*

ONE SPECIAL UNIT... *or a million*



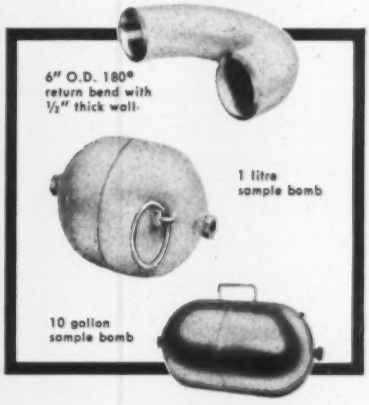
Vacuum pan heater

Requirements for special and standard stainless steel equipment in the chemical field vary widely in point of quantity and design.

That is why the unusual manufacturing and engineering versatility offered by A-P-C matches those requirements so perfectly.

A-P-C's widely experienced engineers are ready to take your ideas or your rough drawings and develop them into precisely the sanitary or corrosion-resistant equipment you want. Or A-P-C will work from *your* engineered drawings to make, literally, ONE UNIT OR A MILLION.

And A-P-C is amply qualified for it is an organization of craftsmen who work *exclusively* in stainless steel and other corrosion-resistant metals.



So, for perfection in craftsmanship, strict quality control, superior manufacturing techniques and ingenious engineering, call in the man from A-P-C.

ALLOY PRODUCTS CORP.

1070 Perkins Ave., Waukesha, Wisconsin

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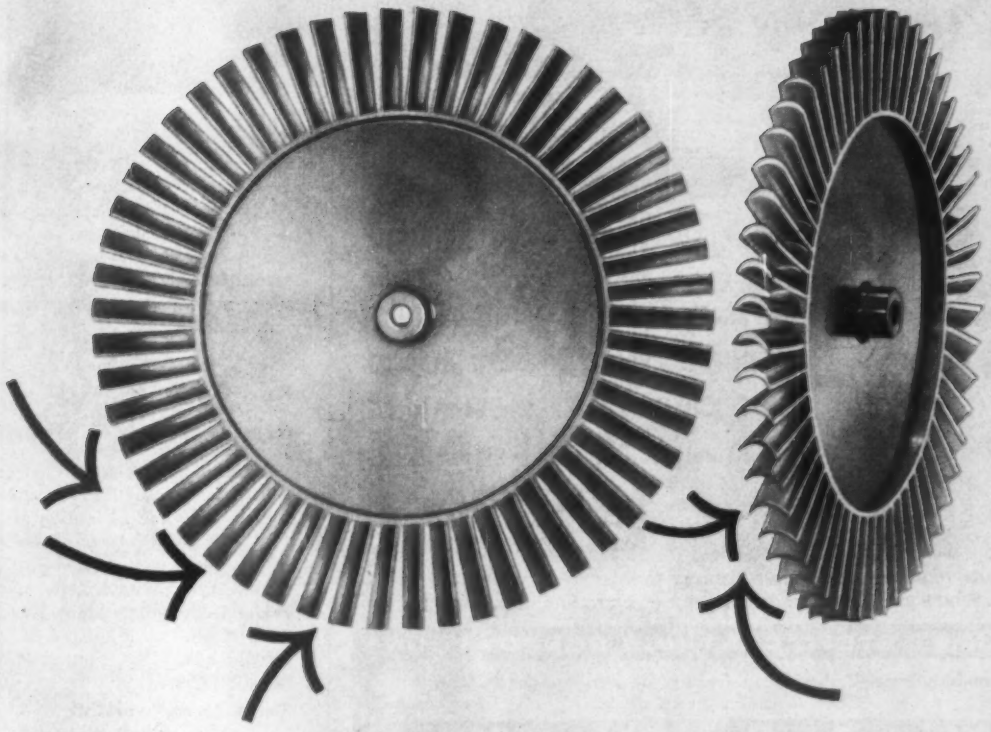
For more information, circle No. 441



More power to Sunbeam vacuum cleaners with this Chicago Molded turbine fan

One of the principal features of the new Sunbeam "Dual De-Luxe" Vacuum Cleaner is the turbine brush. This brush is driven by a unique one-piece turbine fan wheel molded of Nylon. It is believed to be the first plastic single piece molding of a fan incorporating the turbine principle. The fan wheel is made up of 56 curved blades, so spaced as to allow for intake of paper clips, hairpins and similar objects. Nylon was selected for its flexibility and resistance to this metallic impact.

Obviously, this intricate piece presented molding problems. Engineers of Sunbeam and Chicago Molded worked closely together. The answer was a most unusual and complex mold incorporating 56 individual sliding side cores, one for each blade.

Once again the broad experience of Chicago Molded, their knowledge of materials and methods, and their mold-making skill, have combined to lick a tough problem. These important advantages are yours when you deal with CMPC. Why not talk things over with us? Just write or phone. There's no obligation.

See Sweet's Product Design File 2c/Ch, or send for new brochure "Design and Purchase of Custom Molded Plastics."

CMPC

CHICAGO MOLDED PRODUCTS CORPORATION
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For more information, turn to Reader Service card, circle No. 372

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*Patented and patents pending.

PRECIOUS METALS DIVISION
Sel-Rex®
SEL-REX CORPORATION
NUTLEY 10, NEW JERSEY

For more information, turn to Reader Service card, circle No. 417

able beads of polystyrene plastics. Dow calls the texture Frost Wood.

The product is expected to find use in wall coverings, appliances, housewares, thermo-walled ware and decorative packaging. The new texture can be made in different shapes, forms and colors. KEY NO. 625

Synthetic Mica Paper Resists Fire, Solvents

A fire resistant insulation paper is said to be insoluble in water and organic solvents, and to be attacked only slowly by strong alkalis and acids. The paper, prepared from a special type of synthetic mica, is available in pilot plant quantities from Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn. It is called Crystal M.

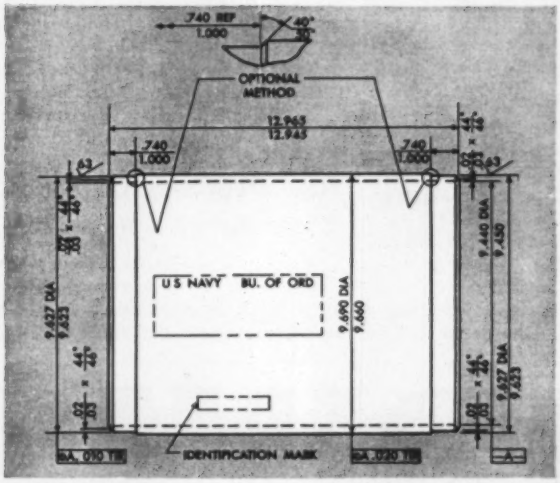
Three forms available

Three forms of the new Crystal M paper are available. One is a 100% synthetic mica paper, and the other two contain fibers (compositions have not been revealed) introduced during the manufacturing process. The producer says the synthetic mica may also be produced in the form of blocks, compression molded shapes with no binders or additives, and finely divided powders. Sheets, boards, mats and blocks can be prepared from almost any powdered or fibrous material in combination with

Large, one-piece plywood panels —Simpson Logging Co., 1032 White Bldg., Seattle, Wash. is now marketing one-piece plywood panels in sizes up to 8 ft wide by 12 ft long as shown above. The panels are said to offer cost and labor savings in the construction of railroad cars, truck bodies, and bus and trailer parts. KEY NO. 626

The Navy said

"CAN YOU"



In the drawing above, a reinforced plastic battery shell that we have made in quantity for the U.S. Navy Bureau of Ordnance. Tolerances were tight . . . such as ±.002" on this 10-1/4" dia. part, which had a wall thickness of only 3/32".

Production was successful, thanks to techniques we were already using for volume production of reinforced plastic pressure tanks.

The same techniques can solve *your* problems! Whether it's tanks or tubs or parts, call us or write. We'll tell you what's possible and whether it's practical.

structural fibers, inc.

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- internal pressure molding
- matched die molding
- premix molding

For more information, turn to Reader Service card, circle No. 419

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Spincraft designed and produced a rigid, lightweight, seamless hog feeder cover to replace an old high-cost, ugly riveted unit.
Result: Improved appearance, reduced cost.

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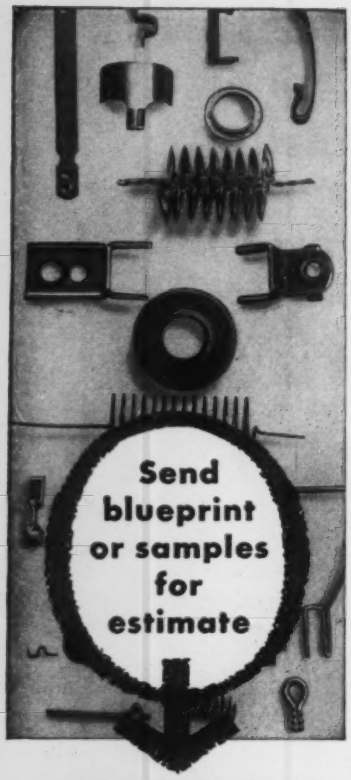

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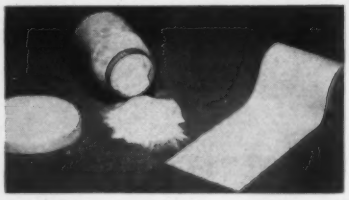
What's new IN MATERIALS



***Three forms** of 3M's new synthetic mica: block, powder and paper.*

Crystal M, 3M says.

Potential uses

Thermal insulation—Thin, fire resistant thermal insulation may be prepared by laminating sheets of the paper together or by laminating the paper to surfaces to be protected. Crystal M paper laminated to metal foils or vapor coated with metal could be used for lightweight fire resistant blankets and drapes, high temperature tapes, pipe wrapping, and fire barriers. The paper could also be made into high temperature, fire resistant honeycomb shapes for curtain wall construction.

Electrical insulation—The synthetic mica paper could be used on wires and cables as a high temperature electrical insulation. Combining the paper with metal foils, plastics sheets, glass cloth or papers saturated with electrical grade resins and oils could produce suitable insulation wrappings and interlayers. Metal fibers, powders and other conductive materials such as graphite can be included in the paper during manufacture to produce a sheet with controlled electrical resistivity.

Properties

Crystal M paper is white. It has an index of refraction of 1.5, a bulk density of 0.09 lb per cu in., a melting point above 1900 F, and a thermal conductivity ranging from 0.30 to 1.5 Btu/hr/sq ft/°F/ft.

KEY NO. 627

New Property Data on Clear Acrylic Resin

More information has been made available on the properties and fabrication of a relatively new, clear acrylic resin called PL-11. The resin,

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A VERSATILE METAL

INDIUM — a high performance bearing metal — increases strength and hardness of bearing. It improves significantly resistance to corrosion by acid from lubricating oils and permits bearing surface to retain oil film better. Where high oil temperatures are encountered, it exhibits longer bearing life.

The high anti-seizure properties of lead-indium bearings make them ideal for heavy or high speed service where dependability and long life are essential. These bearings are now used in most European cars and in many aircraft and diesel engines in both Europe and North America.

INDIUM — a constituent for low melting-point alloys — Wood's metal plus 19% Indium melts at 117°F. Such alloys can be used for foundry patterns, fusible safety links and plugs and many other applications.

INDIUM — a solder material — Indium wets most metals and non-metals making it and many of its alloys a specialized solder for many applications, including glass-to-glass or glass-to-metal seals.

Cominco produces TADANAC Brand INDIUM in a variety of shapes including ingots, plates, wire and ribbon. Standard Grade Indium is 99.97% pure. Can its special qualities be of use to you? Inquiries are invited regarding the application of this versatile metal to your needs. Send for our brochure TADANAC Brand INDIUM.

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● Continental Standard and Special Shaped Wire may be your short cut to lower costs, giving you a ready made molding, product trim or component that requires a minimum of further fabrication. Made under strict quality control, Continental wire customers get a better product and fewer rejects. Write for the complete story of Continental wire today.

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other extruders said it couldn't be done . . .

GENERAL DID IT!

The manufacturer of heaters wanted a hearth bottom—a fluted, gold-anodized aluminum extrusion. Specifications called for a 7" x .050" shape. Extruders with presses that take 8" diameter billets said it couldn't be done because of the thinness, too great a reduction ratio.

G.E.I. engineers came up with the extrusion, on a 5" press! The shape is extruded half round, then straightened, notched and bent, holes punched, and finally gold-anodized.

If you have a problem involving aluminum fabrication, finishing or extrusion, why not take it to General, pioneers in developing new uses for extruded aluminum.

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Consult your classified phone book under Aluminum Products

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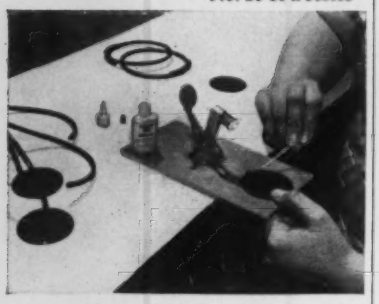
No. 10 of a series



Eastman 910 Adhesive solves another production bottleneck

ASCOP Division of Electro-Mechanical Research, Inc., Princeton, N. J., makes an unique digital encoder which converts any shaft position directly into a binary code output. Operating up to 10,000 r.p.m., the tiny instrument is a masterpiece of compact design.

Space limitations require a flush connection between a vinyl plastic sleeve containing the output wires and an aluminum cover plate. Eastman 910 Adhesive plus imaginative thinking solved the problem.

In production, the end of the sleeve is inserted through a hole in the cover plate, adhesive is applied around the hole and a flaring tool forces the end of the tubing back against the plate. *A permanent bond forms in 2-3 minutes.*

Eastman 910 Adhesive is making possible faster, more economical assembly line operations and new design approaches for many products. It is ideal where extreme speed of setting is important, or where design requirements involve joining small surfaces, complex mechanical fasteners or heat-sensitive elements.

Eastman 910 Adhesive is simple to use. No mixing, heat or pressure is required. Upon spreading into a thin film between two surfaces, setting begins immediately. With most materials, strong bonds are made in minutes.

What production or design problem can this unique adhesive solve for you?

Bonds Almost Instantly ...Without Heat, Pressure or Catalyst

For a trial quantity (⅓-oz.) send five dollars to Armstrong Cork Co., Industrial Adhesives Div., 9102 Dunbar Street, Lancaster, Pa., or to Eastman Chemical Products, Inc., Chemicals Div., Dept. E-2, Kingsport, Tenn. (Not for drug use)

See Sweet's 1960 Prod. Des. File, 7/E

For more information, Circle No. 365

What's new IN MATERIALS

introduced last year by J. T. Baker Chemical Co., Phillipsburg, N. J. (see M/DE, Apr '59, p 154), is similar in mechanical and optical properties to polymethyl methacrylate, but has a heat distortion point about 50 °F higher (250 F at 264 psi).

Property data

The new property data show that the resin has good outdoor weather resistance after aging for one year in Florida, and after aging for one year at the company's New Jersey headquarters.

Laboratory tests show the material has good craze resistance as compared to conventional acrylics. Solvent resistance tests, although incomplete, show the resin has satisfactory resistance to perchloroethylene, acetone, some alcohols, essential oils, and concentrated hot caustic solutions. Comparative tests indicate PL-11 acrylic resin may be suitable for applications requiring moderate resistance to gasoline. However, the resin is not recommended for continuous or frequent exposure to gasoline.

Fabrication data

New fabrication data shows that the resin can be injection molded and extruded by techniques similar to those used for conventional acrylics. It can be metallized, lacquered and dip dyed. **KEY NO. 628**

Wood Hardboard Resists Moisture

A new wood composition hardboard is said to resist climatic changes which ordinarily cause natural wood to swell, shrink, crack, warp and split. The hardboard, called Cultured Wood, is presently being used in the manufacture of furniture. It was developed by Kroehler Mfg. Co., 75 E. Wacker Dr., Chicago.

The hardboard is made by a series of processes in which wood chips are soaked in hot water, steamed, separated into fibers and dried. The dried fibers are then treated with bulking and catalytic chemicals, and consolidated under heat and pressure into a board in which the primary bond is a natural ligneous one.

More detailed information on the properties of hardboard and other

they're safe with **SETKO NU-CUP*** set screws on the job!

Whether it's supporting children on monkey bars or harnessing a spinning shaft you'll find NU-CUP set screws dig in deeper and hold tighter. The shaft illustrated here tells the story.

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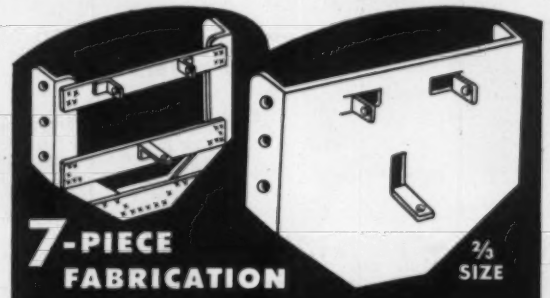

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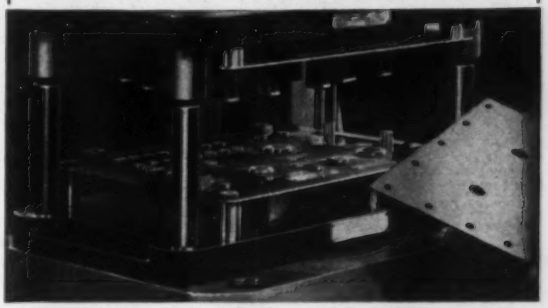

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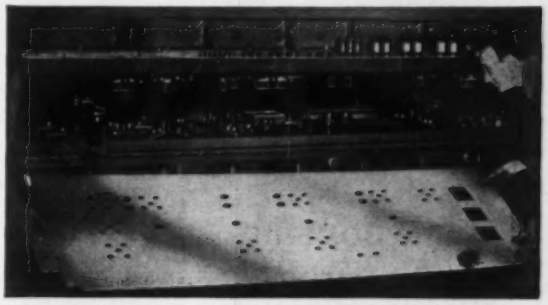

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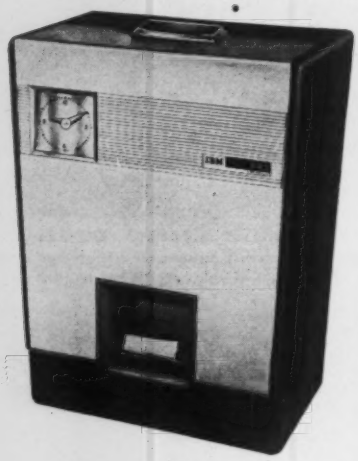

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What's new IN MATERIALS

wood composition boards is given in the Aug '57 issue of this magazine (p 107). KEY NO. 629

Other News . . .

Metals

▸ A ceramic-insulated, boron-free aluminum wire is recommended for use at temperatures up to 1100 F, and for use in nuclear radiation environments. The wire, supplied in diameters from 4 to 100 mils, is available from Technical Industries Corp., 389 N. Fair Oaks Ave., Pasadena, Calif. KEY NO. 630

▸ Special-shaped carbon, low alloy and stainless steel tubing is now available from Standard Tube Co., 24400 Plymouth Rd., Detroit 39. The producer says it has tooling available for producing such shapes as rectangles, squares, stars, ovals, flat ovals, dip-lips, oval crowns and other shapes. KEY NO. 631

▸ Cold rolled rectangular steel tubing is being marketed by Bock Industries, Div. of Elkhart Welding & Boiler Works, Nappanee St. & Hively Ave., Elkhart, Ind. The tubing is available in lengths up to 35 ft. KEY NO. 632

Plastics

▸ Pastel-colored cast acrylic sheets are now available from Cast Optics Corp., 123 Newman St., Hackensack, N. J. Colors are guaranteed for outdoor weather resistance and color stability. KEY NO. 633

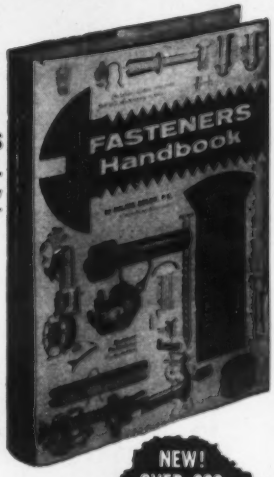
▸ Air Reduction Chemical Co., Div. of Air Reduction Co., Inc., 150 E. 42nd St., New York 17, is now using the generic term "vinal" to identify its line of polyvinyl alcohol fibers. The fibers, introduced this summer (see M/DE, Aug '59, p 154), are supplied in the form of staple and tow. KEY NO. 634

▸ A plastics paste that can be used for automotive, aircraft, industrial, marine and home repairs has been introduced by Baird Dynamic Corp., Plastics Div., Stratford, Conn. The developer says the paste, called Fillerite, can be used to repair dents, cracks, holes, rusted spots and similar damage in one application. KEY NO. 635

▸ Two new flame retardant polyester resins are designed for use in plastics boats. Hetron 353, designed for

Details, ideas, sources for all fastening needs . . .

FASTENERS Handbook



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Consulting Engineer

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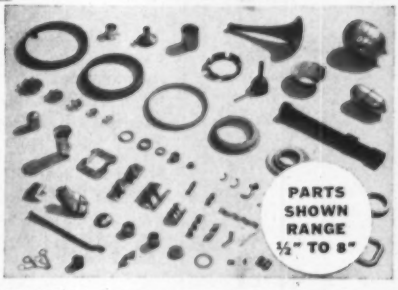

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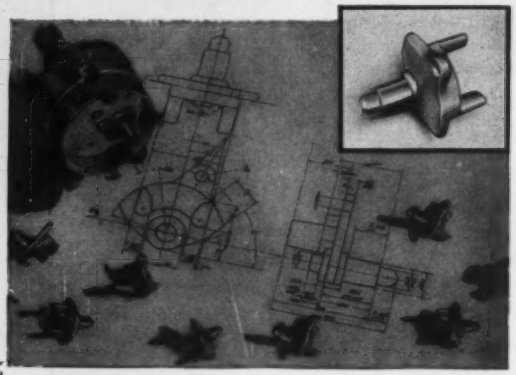

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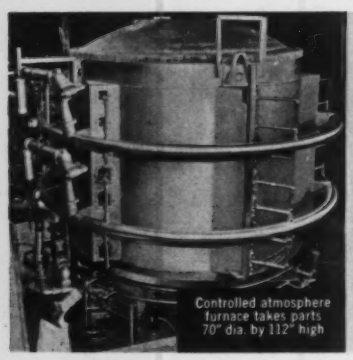

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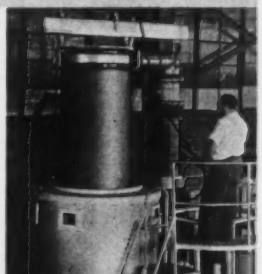

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What's new IN MATERIALS

hand lay-up fabrication techniques, and Hetron 354, designed for fiber-resin spray guns, are both available in commercial quantities from Durez Plastics Div., Hooker Chemical Corp., North Tonawanda, N. Y.

KEY NO. 636

▸ A two-part urethane foam system is said to have long pot life, good adhesion to most materials, good thermal insulating properties, and good shock and vibration resistance. Called Airtemp 5379, the foam is available from Aries Laboratories, Inc., 225 Greenwich Ave., Stamford, Conn. KEY NO. 637

Other nonmetallics

▸ Star Porcelain Co., Muirhead Ave., Trenton 9, N. J. has introduced Lavolain, a steatite ceramic that is said to have high dielectric strength combined with good mechanical properties and good thermal shock resistance. The company is presently supplying the material in the form of bushings in sizes from 0.125 to 0.750 in. long. KEY NO. 638

▸ A medium-viscosity diester hydraulic oil has been designed for use over the temperature range —65 to 350 F. It was developed by Lehigh Chemical Co., Industrial Lubricant Div., Chestertown, Md. The hydraulic oil, called Anderol L-386, is non-gumming and is completely compatible with conventional lubricants, according to the producer.

KEY NO. 639

Finishes

▸ Aroplaz 6006 is the name given to an oil-modified alkyd resin that sets tack-free in about 5 min and hardens into a tough, glossy finish without baking. The resin, designed for use in industrial top coats, was developed by Archer-Daniels-Midland Co., 700 Investors Bldg., Minneapolis 2, Minn.

KEY NO. 640

▸ A new aluminum etchant in solid form is dustless, easy-to-handle, low cost and nonscaling. The product, designated AE-16S, is said to go into solution quickly with a minimum of agitation. It was developed by Pennsalt Chemicals Corp., Metal Processing Dept., 3 Penn Center, Philadelphia 2. KEY NO. 641

▸ Hanson-Van Winkel-Munning Co., Church St., Matawan, N. J. has developed a bright nickel process that is claimed to yield exceptionally bright and smooth nickel deposits. The process is called Superlume.

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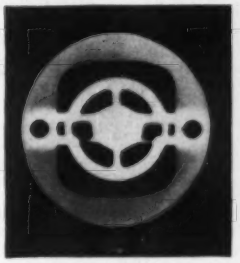

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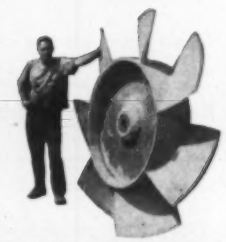

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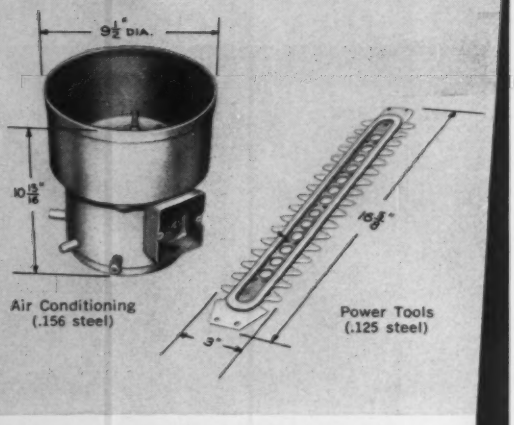

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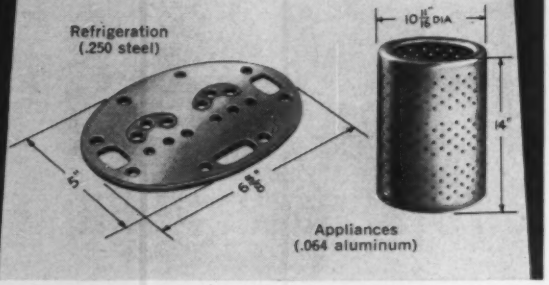

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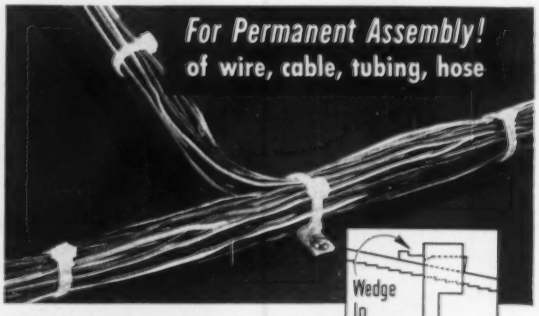

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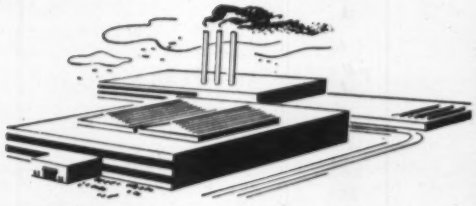

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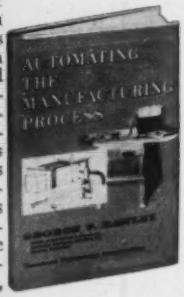

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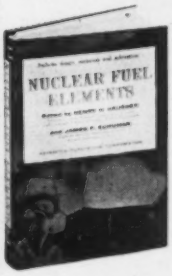

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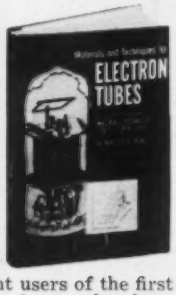
1960, 640 pages, $16.50



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Agency—KLAU-VAN PIETERSON-DUNLAP, INC.

Carlson, G. O., Inc. 75
Agency—FOLTZ-WESSINGER INC.

Cellcote Co., Inc. 166
Agency—PENN AND HAMAKER, INC.

Celanese Plastics Co., Div. of Celanese Corp. of America .....3rd Cover
Agency—ELLINGTON & CO., INC.

Cellusuede Products, Inc. 213
Agency—ROY F. CRATTY AGENCY

Cerro de Pasco Sales Corp. 210
Agency—THOMA & GILL

Chase, W. M. Co. 160
Agency—CLARK & BOBERTZ, INC.

Chicago Molded Products Corp. 199
Agency—MARSTELLER, RICKARD, GEBHARDT AND REED, INC.

Chromalloy Corp. 148
Agency—FAULKNER ADVERTISING, INC.

Consolidated Mining and Smelting Company of Canada, Ltd. 202
Agency—MCKIM ADVERTISING LIMITED

Continental-Diamond Fibre Corp., Subsidiary of Budd Co. 193
Agency—ERWIN WASEY, RUTHRAUFF & RYAN, INC.

Continental Felt Co. 211
Agency—RITTER, SANFORD, PRICE & CHALEK, INC.

Continental Rubber Works 178
Agency—EUGENE C. LAIRD ADVERTISING

Continental Steel Corp. 203
Agency—WESTERN ADVERTISING AGENCY

Copper & Brass Research Association 213
Agency—PAUL SMALLEN ADVERTISING

Corning Glass Works 165
Agency—RUMRILL CO., INC.

Delco Moraine Div., General Motors Corp. 53
Agency—CAMPBELL-EWALD CO.

Dollin Corp. 207
Agency—THOMA & GILL

Dow Corning Corp. 119, 120
Agency—CHURCH AND GUISEWITE ADVERTISING, INC.

Driver, Wilbur B., Co. 146
Agency—GEORGE HOMER MARTIN ASSOCIATES

Dumont Corp. 203
Agency—LENNEN & NEWELL, INC.

du Pont de Nemours, E. I., & Co., Inc., Elastomer Chemicals Dept. 181
Agency—N. W. AYER & SON, INC.

du Pont de Nemours, E. I., & Co., Inc., Film Dept. 167
Agency—BATTEN, BARTON, DURSTINE & OSBORN, INC.

du Pont de Nemours, E. I., & Co., Inc., Polychemicals Dept. 73, 74
Agency—BATTEN, BARTON, DURSTINE & OSBORN, INC.

Duraloy Co. 150
Agency—SANGER-FUNNELL, INC.

Durez Plastics Div., Hooker Chemical Corp. 189
Agency—RUMRILL CO., INC.

Eastern Stainless Steel Corp. 64, 65
Agency—VANSANT, DUGDALE AND CO. INC.

Eastman Chemical Products, Inc., Chemicals Div. 204
Agency—FRED WITTNER CO.

Eastman Chemical Products, Inc., Plastics Div. 80, 81
Agency—FRED WITTNER CO.

Eaton Manufacturing Co., Foundry Div. .. 70
Agency—CLARK & BOBERTZ, INC.

Edgewater Steel Co. 164
Agency—DOWNING INDUSTRIAL ADVERTISING, INC.

Engelhard Industries, Inc. 30, 31
Agency—STUART SANDE ADVERTISING

Fansteel Metallurgical Corp. 84
Agency—SYMONDS, MACKENZIE & CO., INC.

Farley & Loetscher Manufacturing Co., Plastics Div. 211
Agency—CUMMINGS, BRAND & MCPHERSON

Federal Tool & Manufacturing Co. 142
Agency—FABER ADVERTISING, INC.

Felters Co. 176
Agency—SUTHERLAND-ABBOTT

Ferro Corp., Fiber Glass Div. 151
Agency—FULLER & SMITH & ROSS INC.

Foster Grant Co., Inc. 63
Agency—DONAHUE & COE, INC.

Frasse, Peter A., & Co., Inc. 197
Agency—PICARD ADVERTISING, INC.

Frontier Bronze Corp. 209
Agency—MELVIN F. HALL ADVERTISING AGENCY, INC.

Garlock Packing Co. 143
Agency—HUTCHINS ADVERTISING CO., INC.

General American Transportation Corp., Konigen Div. 52
Agency—EDWARD H. WEISS AND CO.

General Extrusions, Inc. 203
Agency—R. J. MCCALLISTER CO.

Goodrich, B. F., Chemical Co. 7
Agency—GRISWOLD-ESHLEMAN CO.

Goodrich, B. F. Co. 8
Agency—GRISWOLD-ESHLEMAN CO.

Goodrich-Gulf Chemicals, Inc. 168, 169
Agency—GRISWOLD-ESHLEMAN CO.

Goshen Rubber Co., Inc. 133
Agency—CHAMBERLIN-JUNK ADVERTISING INC.

Grace, W. R., & Co., Polymer Chemicals Div. 140, 141
Agency—CHARLES W. HOYT CO., INC.

Gries Reproducer Corp. 208
Agency—HAROLD MARSHALL ADVERTISING CO., INC.

Handy & Harman 153
Agency—HAZARD ADVERTISING CO., INC.

Harshaw Chemical Co. 122

Haynes Stellite Co., Div. of Union Carbide Corp. 124
Agency—J. M. MATHES, INC.

Hull, R. O., & Co., Inc. 136
Agency—RALPH M. FRENCH ADVERTISING.

Hysol Corp. 66
Agency—BARBER & DRULLARD INC.

Indium Corporation of America 207
Agency—FARQUHAR AND CO., INC.

International Nickel Co., Inc. 4
Agency—MARSCHALK AND PRATT, DIV. OF MCCANN-ERICKSON, INC.

International Packings Corp. 171
Agency—COONEY & CONNOR

Jones & Laughlin Steel Corp., Stainless and Strip Div. 185
Agency—PALMER, CORDELLA AND ASSOCIATES, INC.

La Salle Steel Co. 21
Agency—FENSHOLT ADVERTISING AGENCY, INC.

Latrobe Steel Co. 28
Agency—MCHENRY-DEREK ADVERTISING

Lead Industries Association 179
Agency—O. S. TYSON AND CO., INC.

Lukens Steel Co. 195
Agency—J. M. MATHES, INC.

Malleable Castings Council 26, 27
Agency—Carr Liggett Advertising, Inc.

McDanel Refractory Porcelain Co. 194
Agency—Meek and Thomas, Inc.

McLouth Steel Corp. 71
Agency—Denman & Baker, Inc.

Metallizing Engineering Co., Inc. 161
Agency—Schuyler Hopper Co.

Midland Industrial Finishes Co. 170
Agency—Western Advertising Agency Inc.

Minnesota Mining & Manufacturing Co., Adhesives, Coatings and Sealers Div. .. 62
Agency—MacManus, John & Adams, Inc.

Minnesota Mining & Manufacturing Co., Reinforced Plastics Div. 24, 25
Agency—Batten, Barton, Durstine & Osborn, Inc.

Molded Fiber Glass Co. 206
Agency—Carpenter Advertising Co.

Monsanto Chemical Co., Plastics Div. ..76, 77
Agency—Needham, Louis and Brorby, Inc.

Morganite, Inc. 174
Agency—George Homer Martin Associates

Mt. Vernon Die Casting Corp. 82
Agency—Mogul, Williams & Saylor, Inc.

Mycalex Corporation of America 17
Agency—Kelly, Nason, Inc.

National-Standard Co. 34, 35
Agency—Marsteller, Rickard, Gebhardt and Reed, Inc.

National Tube Div., United States Steel Corp. 175
Agency—Batten, Barton, Durstine & Osborn, Inc.

National Vulcanized Fibre Co. 158, 159
Agency—Harris D. McKinney, Inc.

Neilson Chemical Co. 205
Agency—Dudgeon, Taylor & Bruske, Inc.

New Jersey Zinc Co. 2, 3

Newark Wire Cloth Co. 154
Agency—Sanger-Funnell Inc.

Norton Co., Electrochemical Div. 152
Agency—James Thomas Chirurg Co.

Oakite Products, Inc. 172
Agency—Marsteller, Rickard, Gebhardt and Reed, Inc.

Olsen, Tinius, Testing Machine Co. 186
Agency—Renner, Inc.

Pressed Steel Tank Co. 138
Agency—Buchen Co.

Pure Carbon Co., Inc. 20
Agency—John Harder Fenstermacher

Raybestos-Manhattan, Inc., Adhesive Dept. 72
Agency—Gray & Rogers

Raybestos-Manhattan, Inc., Plastic Products Div. 180
Agency—Gray & Rogers

Reeves Brothers, Inc., Vulcan Rubber Products Div. 18
Agency—Ketchum, MacLeod & Grove, Inc.

Reichert Float & Manufacturing Co. 207
Agency—Wendt Advertising Agency

Reichhold Chemicals, Inc. 17
Agency—MacManus, John & Adams, Inc.

Reinhold Publishing Corp. 134, 206, 212

Republic Steel Corp. 162, 163
Agency—Meldrum & Fewsmith, Inc.

Reynolds Chemical Products Company, Div. of Stubnitz-Greene Corp. 184
Agency—LesStrang Associates

Rockwell-Standard Corp., Stamping Div. .. 210
Agency—MacFarland, Aveyard & Co.

Rogers, Dayton, Manufacturing Co. 205
Agency—Keystone Advertising, Inc.

Russell, Burdsall & Ward Bolt and Nut Co. 54
Agency—Marsteller, Rickard, Gebhardt and Reed, Inc.

Ryerson, Joseph T., & Son, Inc. 86
Agency—Buchen Co.

St. Joseph Lead Co. 48
Agency—Emil Mark & Co.

Saunders, Alexander, & Co. 211
Agency—Steve Devore Co.

Scott Testers, Inc. 196
Agency—Horton, Church & Goff, Inc.

Sel-Rex Corp. 200
Agency—Bass and Co., Inc.

Set Screw & Manufacturing Co. 204
Agency—Hanson & Stevens Inc.

Sharon Steel Corp. 68, 69
Agency—Duffy, McClure & Wilder, Inc.

Shell Chemical Corp., Plastics and Resins Div. 10
Agency—J. Walter Thompson Co.

Sherwin-Williams Co., General Industrial Div. 32
Agency—Fuller & Smith & Ross Inc.

Sifco Metachemical, Inc. 198
Agency—Crier Advertising

Simmons Fastener Corp. 173
Agency—Fred Wittner Co.

Somers Brass Co., Inc. 159
Agency—Charles Palm & Co., Inc.

Spencer Chemical Co. 58
Agency—Bruce B. Brewer & Co.

Spincraft, Inc. 201
Agency—Mautner Agency

Stackpole Carbon Co. 190
Agency—Harry P. Bridge Co.

Standard Tube Co. 155
Agency—Zimmer, Keller & Calvert, Inc.

Structural Fibers, Inc. 201
Agency—Clark & Bobertz, Inc.

Swedlow Inc. 83
Agency—Willard G. Gregory & Co.

Sylvania Electric Products Inc., Parts Div. 59
Agency—Kudner Agency, Inc.

Synthane Corp. 177
Agency—Arndt, Preston, Chapin, Lamb & Keen, Inc.

Tempil Corp. 196
Agency—RAF Advertising Inc.

Texas Instruments Inc., Metals & Controls Div. 36
Agency—Sutherland-Abbott

Thompson, H. I., Fiber Glass Co. 67
Agency—Van der Boom, Hunt, McNaughton, Inc.

Timken Roller Bearing Co., Steel & Tube Div. .....Back Cover
Agency—Batten, Barton, Durstine & Osborn, Inc.

Tinnerman Products, Inc. 50
Agency—Meldrum & Fewsmith, Inc.

Union Carbide Plastics Co., Div. of Union Carbide Corp. 147
Agency—J. M. Mathes, Inc.

Unitcast Corp. 188
Agency—T. J. Stead, Advertising

United States Graphite Co. 137
Agency—Price, Tanner & Willox, Inc.

United States Rubber Co., U. S. Kem-Blo Dept. 209
Agency—Fletcher Richards, Calkins & Holden, Inc.

United States Stoneware Co. 149
Agency—Ralph Gross Advertising, Inc.

United States Testing Co., Inc. 156
Agency—W. L. Towne Co., Inc.

Vanadium Corporation of America 157
Agency—Hazard Advertising Co., Inc.

Van Huffel Tube Corp. 57
Agency—Chamberlin-Junk Advertising Inc.

Vascoloy-Ramet Corp. 187
Agency—E. R. Hollingsworth & Associates

Wall Colmonoy Corp., Stainless Processing Div. 208
Agency—Hemsing Advertising

Washington Steel Corp. 192
Agency—Cabbot & Coffman, Inc.

Weckesser Co. 210
Agency—Symonds, MacKenzie & Co., Inc.

Whistler, S. B., & Sons, Inc. 205
Agency—Harold Warner Co.

White Metal Rolling & Stamping Corp. .. 133
Agency—Harold Marshall Advertising Co., Inc.

Williams-Bowman Rubber Co. 213
Agency—William J. Narup and Co.

Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc. 182
Agency—Reincke, Meyer & Finn, Inc.

Wolverine Tube Div., Calumet & Hecla, Inc. 139
Agency—Gray & Kilgore, Inc.

Wyman-Gordon Co. 78, 79
Agency—Davis Press, Inc.

Zirconium Metals Corp. of America, Div. of National Lead Co. 47
Agency—Comstock & Co.

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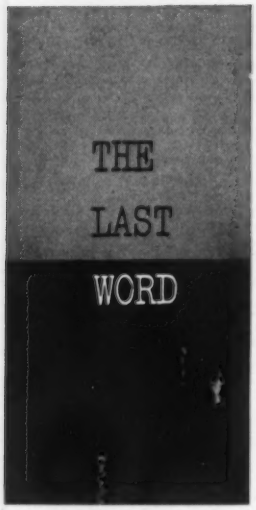


Engineers Can Be Corrupted, Too

by ***H. R. Clauser***
Editor

In recent months the headlines on questionable practices and ethics in TV and radio have made it easy for us to point the finger at one industry and to forget that no one has a monopoly on "sin." But the ethical issues involved in payola, misleading advertising, and rigged quiz shows are not new nor are they much different from those faced in our daily work.

Engineers face temptation

A recently published novel, "The Tempter," by Norbert Wiener, brilliant mathematician, engineer and originator of cybernetics, is a forceful reminder of this fact. It would be well for every engineer and scientist to read it, for it reminds us that engineers, like everyone else, must face temptation; that far from being a cloistered profession, engineering is very much involved in the "practical" world; and that being thus involved, engineers should be fully aware that the commercial world is a corrupting one.

For some a good end is enough

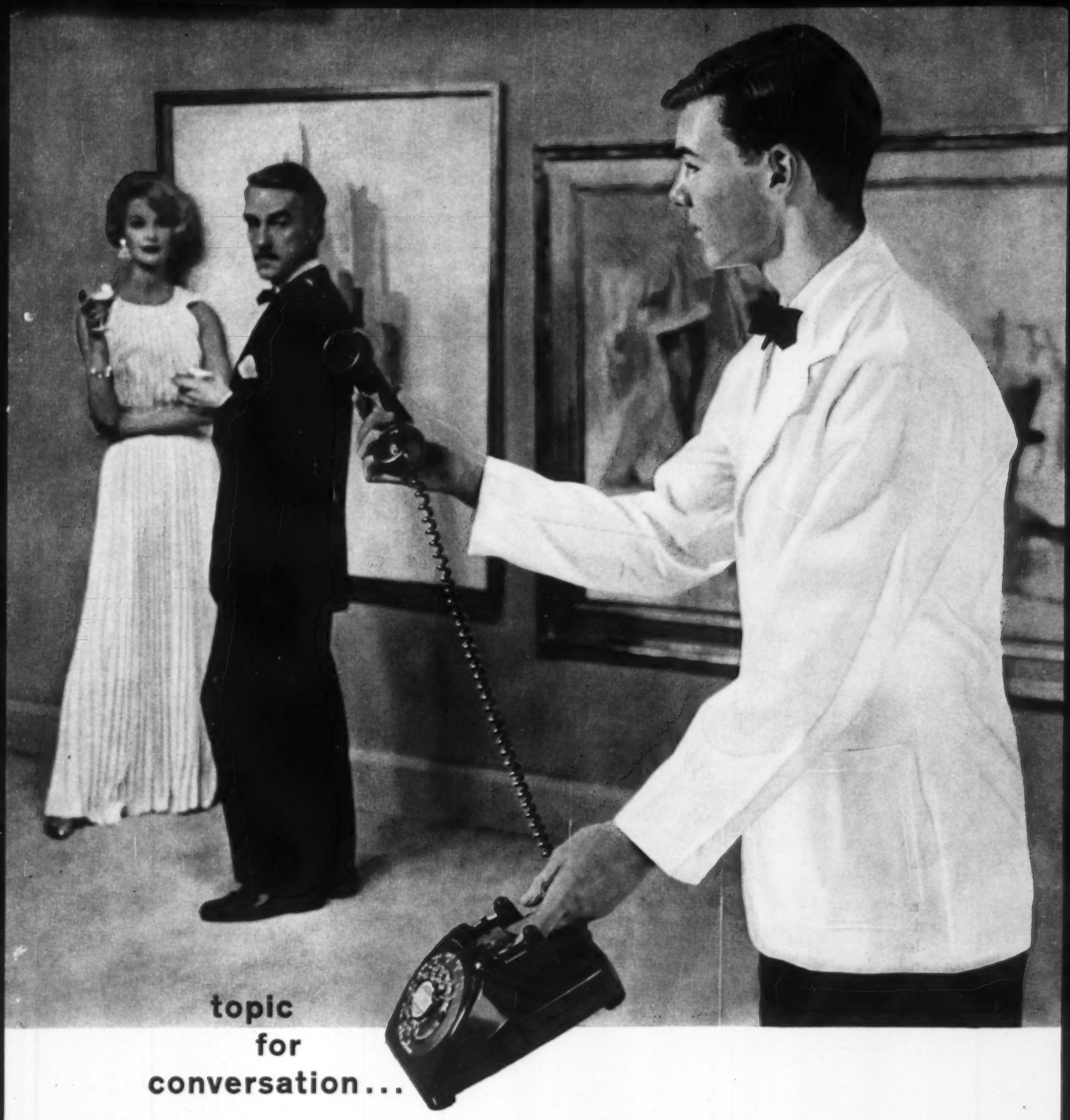
It is not an elevating picture the author draws of three engineers who figure prominently in the story. All three not only acquiesce but also take part in the questionable practices of an electronic controls company. And they try to assuage their consciences with the ages-old hokum that good ends justify not-so-good means. There is James, the chief engineer, "who felt himself to be idealistic and a bit of a rebel, and who actually was both, (yet) lent himself to the distasteful work of patent chicanery." There is Watman, a self-effacing "engineer's engineer" who is willing to overlook the dubious ethics of what he is doing for security and for the "fun (of working) in a field which has real possibilities." And there is Dominguez, a vain and ambitious professor, who sells his soul to gain unearned recognition and a fat consulting check.

Where to draw the line?

Most of us probably would not go as far as the fictional engineers in "The Tempter." But how far can or should an engineer go? To what extent should an engineer compromise on the quality of materials at the expense of product performance in order to satisfy the demands of the sales manager, either for a more competitively priced item or to maintain a replacement market? To what extent should an engineer cooperate in approving the "technical" details of his company's advertising brochures which are misleading or which don't tell the whole story? To what extent should an engineer ignore overly stringent test or inspection standards in order to meet production schedules? All of us could list many other similar questions. Each question alone may appear of minor significance, but when taken together, their sum total makes the question "How far can I go?" of great importance.

Each must answer for himself

Well, how far *can* I go? There is no pat answer to this question, and no one can answer for us. Codes of ethics and a sense of professional pride can bolster us in the face of temptation, but in the final analysis we must stand alone and depend upon our own deep feelings and sense of honesty to guide our conduct in our professional life.



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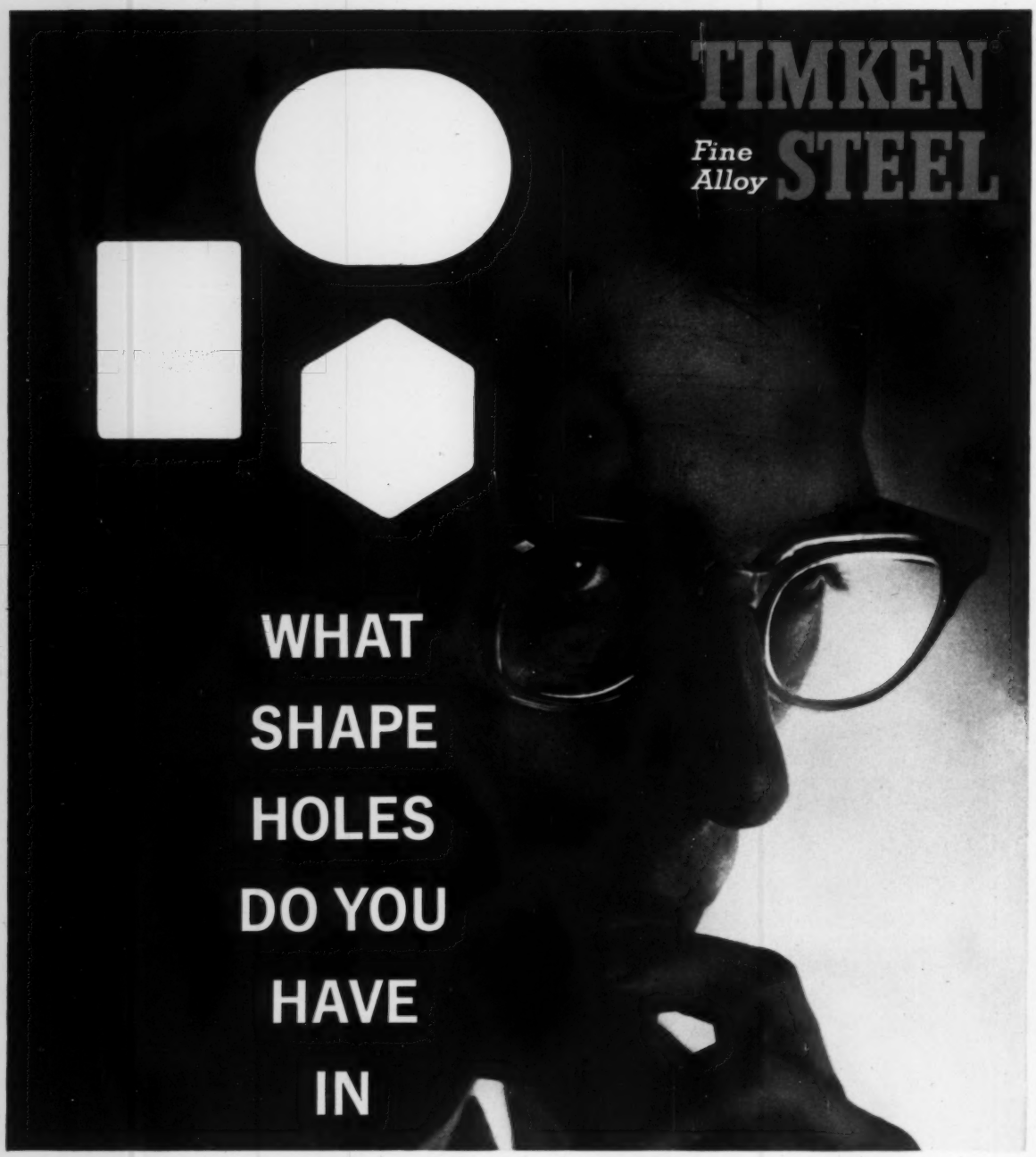

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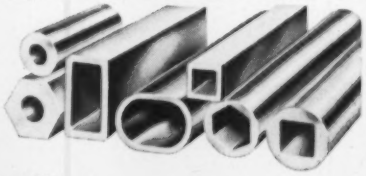

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